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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

DETAILED ACTION

Claims 1-2 and 5-22 were rejected in the Office Action entered on 11 March 2010.

Applicants' response submitted on 10 June 2010 has amended claims 1, 2, 7, 12, 13, 14, 17, 18, 19, and 22. Claims 1-2 and 5-22 are pending in this application.

Claims 1-2 and 5-22 are rejected.

Response to Remarks - 35 USC § 103

1. In response to the previous rejection of claims 1, 2, and 5-21 under 35 U.S.C. § 103(a) as being unpatentable over Sebastian in view of Shebini, and Barequet, Applicants argue primarily that:

The Office Action, at page 12, acknowledges that Sebastian and Shebini do not explicitly teach errors determined using a corresponding surface group including at least one of a change of a number of configuring surfaces, a change in direction or quantity of border lines, reversal of a direction of a surface, and folding of a surface, but apparently alleges that Barequet discloses these claims features. Applicant respectfully disagrees.

Barequet discloses "an algorithm for repairing polyhedral CAD models that have errors in their B-REP [Boundary Representation]. Errors like cracks, degeneracies, duplication, holes and overlaps..." Barequet, Abstract, pg 363. Barequet further refers to "algorithms to eliminate dangling geometry, T-Joints, holes and cracks in a polygonal solid model and generate consistent polygon-orientations." Barequet, Introduction, pg. 363. Barequet describes an automated algorithm that operates by shifting the vertices of the polygons within a single shape model. *Id.* 364. The technique of Barequet "takes as input a soup of polygons and outputs the adjacency structure of the corrected model." *Id.* A "soup of polygons" is described by Barequet at page 363 as a technique of representing a CAD model. Barequet, therefore, teaches a technique which receives a single CAD model represented by a soup of polygons as input, performs the automated task of vertex shifting to correct certain errors, and outputs the structure of the single corrected model.

In contrast, independent claims 1, 2, 7, 9, 11-15, and 17-20 recite the use of a user-generated corresponding surface group to determine errors including "at least one of a change of a number of configuring surfaces, a change in direction or quantity of border lines, reversal of a direction of a surface, and folding of a surface," in a combined shape model. Barequet fails to disclose, teach, or suggest the use of a user-generated

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corresponding surface group in order to determine any such error. Barequet merely discloses an automated technique of comparing and shifting vertices to correct errors.

The Examiner respectfully traverses this argument as follows.

Applicants claim, *inter alia*, determining errors including "at least one of ... a change in direction or quantity of border lines". Barequet clearly teaches the same [*"Figure 1: A synthetic broken cube, (a) Original model, (b) Repaired model"* (Barequet, page 363)]. As can clearly be seen from the drawing in Barequet, the "original model" including the errors contains additional border lines. By changing the quantity of border lines, the "repaired model" (b) is generated. Therefore the Examiner maintains that Barequet teaches, *inter alia*, determining errors including "at least one of a change of a number of configuring surfaces, a change in direction or quantity of border lines, reversal of a direction of a surface, and folding of a surface".

2. Applicants further argue that:

Barequet also fails to disclose, teach, or suggest the use of a combined shape model created from multiple work history data, wherein the combined shape model is formed by joining part shape models. Barequet merely discloses a technique of correcting errors within a single CAD model representation, and not one or more errors in a combined shape model, as recited by the independent claims. Thus Barequet teaches a different technique in a different type of model as compared to the independent claims.

The Examiner respectfully traverses this argument as follows.

Applicant's claim 1 clearly recites: *"combine the at least two selected unit work history data and output design work data for creating a combined shape model ... which is formed by reproducing the selected unit work history and joining part shape models corresponding to the respective selected unit work history data"*. That is, Applicant's claimed invention produces a single **combined shape model** by joining part shape models. The **combined shape model** is a

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single CAD model representation, and there is no claim language or disclosure in this application to suggest otherwise.

In the prior art, Sebastian teaches combining work histories to produce a ***combined shape model*** which is a single CAD model representation (Sebastian, columns 11-12, specific citations can be found in the formal rejection). Barequet merely discloses a technique of correcting errors within a single CAD model representation [Applicant's remarks]. Therefore, when properly combined as shown in the previous rejection, the prior art renders obvious an invention comprising the step of *"combine the at least two selected unit work history data and output design work data for creating a combined shape model ... which is formed by reproducing the selected unit work history and joining part shape models corresponding to the respective selected unit work history data" and "determine, using the corresponding surface group, errors in the combined shape model arising from the second reference surface... wherein the errors determined using the corresponding surface group include at least one of a change of a number of configuring surfaces, a change in direction or quantity of border lines, reversal of a direction of a surface, and folding of a surface."*

3. Applicants further argue that:

The Office Action alleges that "[t]he combination [of alleged teachings of Sebastian and Barequet] could be achieved by using Barequet's algorithms in the system and method described by Sebastian to identify and correct the same types of errors in Sebastian's CAD models." Office Action, pg. 7. However, even if the error identifying algorithms of Barequet could be used in Sebastian's CAD model (a notion that Applicant disputes) the hypothetical combination of Barequet and Sebastian would not have the recited claim feature "wherein the errors determined using the corresponding surface group include at least one of a change of a number of configuring surfaces, a change in direction or quantity of border lines, reversal of a direction of a surface, and folding of a surface," as recited in claims 1, 2, 7, 9, 11-15, and 17-20. Indeed, as compared to these independent

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claims, Barequet discloses an entirely different error identifying algorithm applied to a different model. Barequet discloses the use of an automated vertex shifting algorithm to correct errors in a single CAD model, which is entirely different from using a corresponding surface group to determine errors in a combined shape model, as recited in claims 1, 2, 7, 9, 11-15, and 17-20.

The Examiner respectfully traverses this argument as follows.

Applicant's allegation that "compared to these independent claims, Barequet discloses entirely different error identifying algorithm" is unpersuasive because the independent claims recite no language that particularly describes *any* error identifying algorithm. In contrast, the independent claims recite *which errors are identified*, and by *not describing the error identifying algorithm*, it is clear that according to the basic principles of claim construction, the invention is not limited to any particular type of error identifying algorithm. Instead, the invention is limited to *which errors are identified* as recited by the claim. Barequet has been shown (immediately above, and in the previous rejection) to identify errors according to the claim language. The Examiner submits that the concept of "surface groups" as taught by Applicant's specification is vague and not clearly defined. Barequet teaches a repair algorithm that generates "manifolds", which appear to correspond to "surface groups" (Barequet, "1.2 Our Approach", page 364). Therefore the Examiner maintains that Barequet teaches, *inter alia*, the type of error identifying algorithm required by the claims.

Further, Applicant's allegation that the claimed model ("*a combined shape model... which is formed by sequentially reproducing the selected unit work history and joining part shape models corresponding to the respective selected unit work history data*") is "a different model" than "a single CAD model representation" (contemplated by Barequet) is unpersuasive. As noted above, Sebastian teaches the creation of "*a combined shape model*," while Barequet

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teaches identification of errors in "a single CAD model representation" (i.e., a combined shape model).

Further, the Examiner has shown above, and in the previous rejection, that Barequet teaches, *inter alia*, determining errors including "at least one of a change of a number of configuring surfaces, a change in direction or quantity of border lines, reversal of a direction of a surface, and folding of a surface".

4. Applicants further argue that:

The Office Action apparently asserts, at page 9, that Sebastian discloses the use of a corresponding surface group to determine errors in a combined shape model. While not explicitly stated, it appears that the Office Action may be relying on Sebastian as purportedly disclosing the claimed error identifying technique and Barequet as purportedly disclosing the claimed errors to be identified. This combination, however, is inappropriate because the independent claims recite a technique to determine one or more of certain types of errors in a particular type of shape model, a combined shape model. Any errors detected in a different type of shape model, e.g., a single CAD model, must be different errors.

The Examiner respectfully traverses this argument as follows.

Applicants' argument that "Any errors detected in a different type of shape model, e.g., a single CAD model, must be different errors [than detected errors in "a combined shape model"] is unpersuasive. A ***combined shape model*** is a single CAD model. Naturally, an error in a single CAD model may be the same as an error in a single CAD model.

However, the Examiner encourages Applicants to clarify the definition of "a combined shape model" as supported by the disclosure of this application such that "a combined shape model" is something other than a single CAD model. The Examiner respectfully submits that

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combining two part shape models to form a combined shape model clearly indicates that the resulting *combined shape model* is a single CAD model. The Examiner interprets the word "combined" and "combining" according to a dictionary definition.

5. Applicants further argue that:

Even, hypothetically, if the technique of Sebastian were to be interpreted to correspond to the technique recited by the claims (a notion that Applicant disputes) and the errors determined by the technique of Barequet were to be interpreted to correspond to the determined errors recited by the claims (another notion that Applicant disputes), mixing and matching techniques and results in this fashion would not have been obvious to one of ordinary skill in the art. A person of ordinary skill in the art would not have had any legitimate reason to assume that a technique described in one reference might produce the same results as an entirely different technique described in a different reference. Even if the asserted error determination techniques of Sebastian were to produce the same results as the wholly different technique of Barequet, there would not have been any legitimate reason to believe that Sebastian's techniques might achieve Barequet's results.

The Examiner respectfully traverses this argument as follows.

Applicant's disputes are noted, and have been addressed above.

The combination of the prior art has been clearly set forth in the previous Office Action.

The previous rejection clearly set forth how a person would be motivated to combine the teachings of Sebastian and Barequet, reproduced below:

It would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian with Barequet as expressly motivated by Barequet to identify and correct problems in the CAD model [*"File formats like IGES ... DXF ... and STL ... (which is a de facto standard in the rapid-prototyping industry) allow users to represent models as such soups of polygons... The collection of polygons is assumed to represent a complete model. Unfortunately this is often not the case. Typical problems include cracks (in the surface), degeneracies, duplication (of patches of the surface), holes and overlaps, as shown in Figure 1... We present algorithms to eliminate dangling geometry, T-joins, holes and cracks in a polygonal solid model, and generate consistent polygon-orientations."* (Barequet, page 363, "1 Introduction")]. The combination could be achieved by using Barequet's algorithms in the system and method described by Sebastian to identify and correct the same types of

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errors in Sebastian's CAD models. The combination would produce a system as described by Sebastian but enhanced with the error identification and correction techniques taught by Barequet. (Previous Office Action, page 7)

In summary, Sebastian teaches some error detection techniques, while Barequet teaches additional error detection techniques (or, in Applicant's words, "*an entirely different technique*"). However, both techniques are employed to detect errors in a CAD model, and (as previously stated) it would have been obvious to combine these teachings in order to identify and correct the problems in a CAD model discussed by Barequet.

The Examiner is unaware of a requirement in 35 U.S.C. § 103 or relevant case law that the prior art references are required to "produce the same results". To the contrary, a rejection under 35 U.S.C. § 103(a) typically combines the analogous, but separate teachings of the prior art, motivated by the teachings of the prior art or the knowledge of a person having ordinary skill in the art, to produce a *prima facie* case of obviousness for the claimed invention. The Examiner respectfully submits that this is the procedure that has been followed in rejecting these claims, and that Applicant's arguments to the contrary have been fully considered but have been found unpersuasive.

6. Applicants further argue that:

Regarding the claim feature wherein a "shape model, comprising a second reference surface.., is formed by sequentially reproducing the selected unit work history," a recited in amended claim 1, and similarly in previously presented claims 9, 11, 15 and 20 and currently amended claims 2, 7, 12-14, and 17-19, the Office Action, at page 26, asserts that Sebastian, at col. 11, lines 32-49 and col. 12, lines 3-11 teaches this feature. Sebastian, however, discloses a "template scheme [that] provides a uniform data handling mechanism that spans the domain of part, tooling, process and material," col. 11, lines 32-34. Each "feature template is a representation of a primitive object which has a form and a function," col. 12, lines 3-4, that "can be combined to create macro-feature templates," col 11, lines 56-57. Thus, Sebastian merely discloses a data handling

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mechanism that utilizes primitive feature templates that may be combined to form more complex parts.

The Examiner respectfully traverses this argument as follows.

Applicants claim: *combine the at least two selected unit work history data and output design work data for creating a combined shape model, comprising a second reference surface, which is formed by sequentially reproducing the selected unit work history and joining part shape models corresponding to the respective selected unit work history data*

Applicants admit that Sebastian teaches: *"a data handling mechanism that utilizes primitive feature templates that may be combined to form more complex parts"*

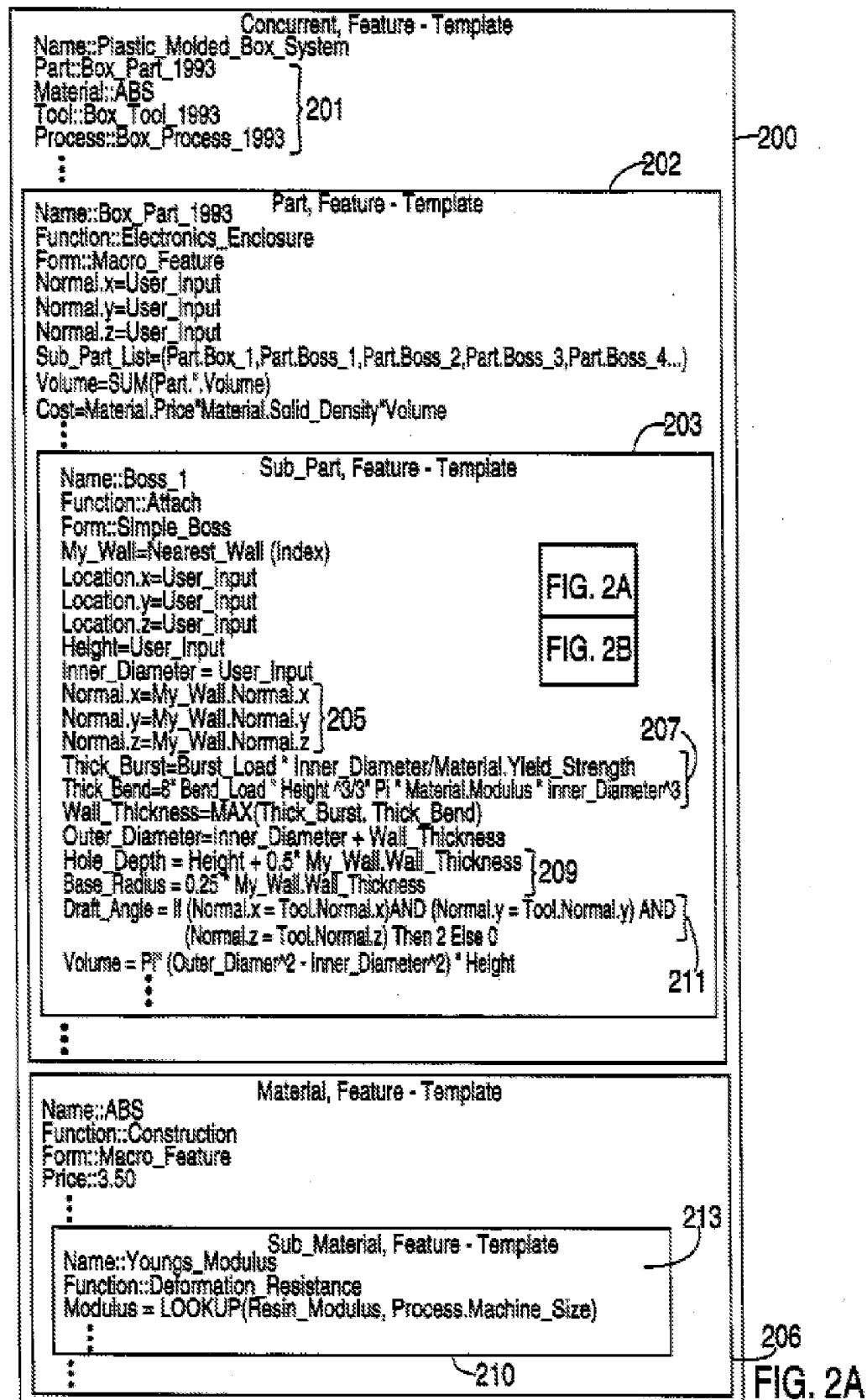
Additionally, Sebastian teaches

"Referring now to FIGS. 2A and 2B, there is illustrated an exemplary feature template 200. The feature template 200 comprises four templates, namely, a part-feature template 202, a process-feature template 204, a material-feature template 206 and a tool-feature template 208. The feature template 200 can be regarded as being a master template with pointers 201 to domain specific templates (e.g., 202, 204, 206 and 208). In the example of FIGS. 2A and 2B, the feature template represents a plastic molded box that is made using injection molding.

The part-feature template 202 represents a box. The function of the box is an electrical enclosure. Part-feature template incorporate sub-part feature templates that represent the sub-parts that are used to make the part represented by the part-feature template. For example, a "Boss_1" sub-part feature template 203 is shown that represents a boss that has an attach function. (Other sub-parts are used to make the box represented by part-feature template 202, but are not shown in FIGS. 2A and 2B.)"(Sebastian, column 12, line 39 - column 12, line 57)]

That is, Sebastian clearly teaches forming a "combined shape model" by joining part shape models corresponding to the respective selected work history data. Sebastian's FIGS. 2A and 2B show:

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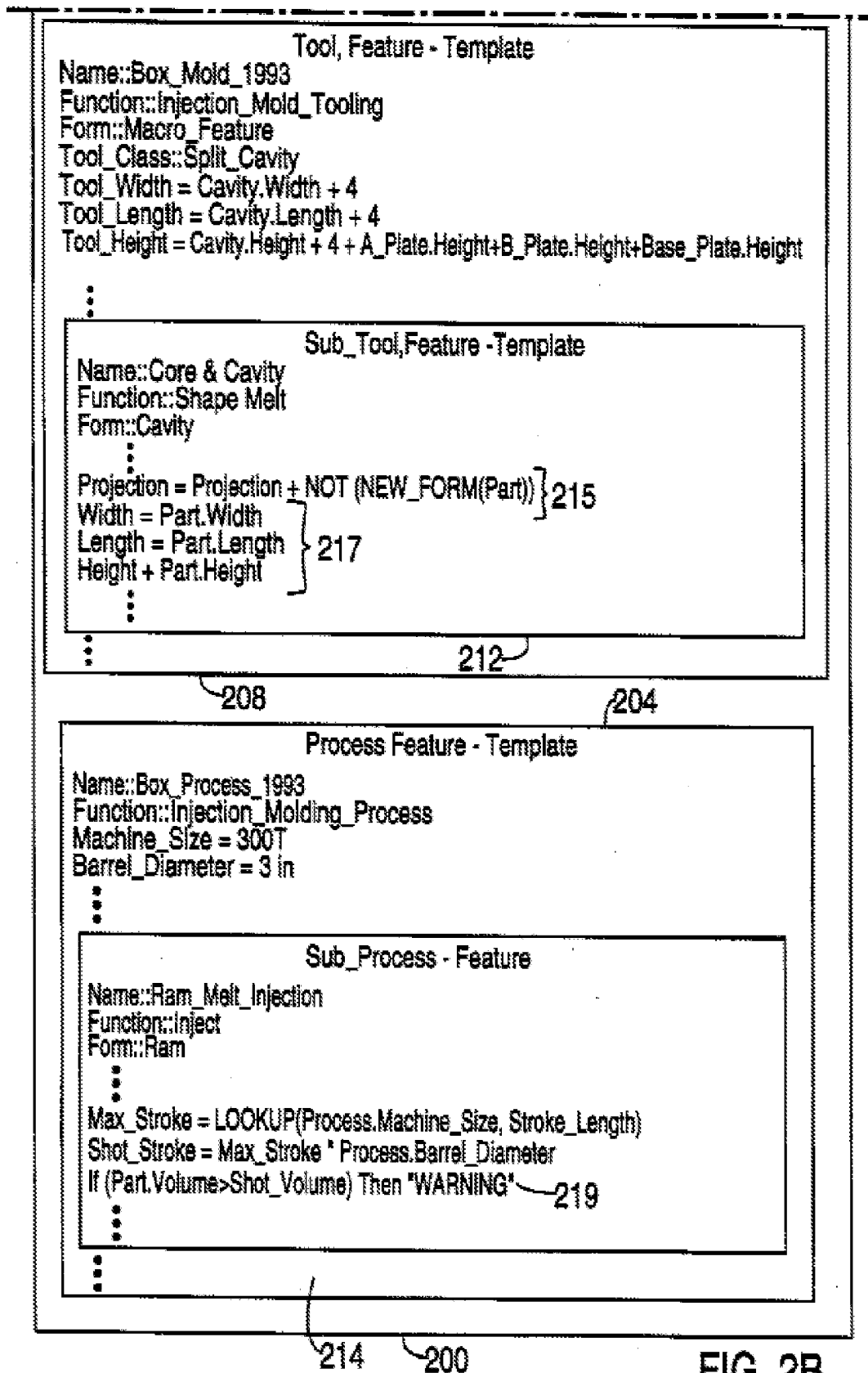


FIG. 2B

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These Figures show how feature templates are stored "unit work history data", and how the "Plastic_Molded_Box_System" part is formed by "sequentially reproducing the selected unit work history". The definition of the Plastic_Molded_Box_System comprises a *sequence* of feature templates, each feature template representing stored "unit work history data," and some of the feature templates representing "part shape models corresponding to the respective selected work history data".

7. Applicants further argue that:

In contrast, amended claim 1, for instance, recite "creating a combined shape model, comprising a second reference surface, which is formed by sequentially reproducing the selected unit work history." This involves creating a shape by sequentially stepping through individual design procedures used to create the unit work history, e.g., as detailed in the instant specification at page 17, lines 13-26. This feature of amended claim 1 permits sequentially stepping through each single design procedure, such as designating a primitive or inputting coordinate values, used to create a shape for which unit work history has been stored. Sebastian discloses only the combination of previously stored feature templates, which are created through a long series of design procedures. Sebastian does not disclose or suggest the creation of a shape by sequentially reproducing unit work history data.

The Examiner respectfully traverses this argument as follows.

As shown above, Sebastian teaches the quoted claim language. The remainder of Applicant's argument is not coextensive with the scope of the claims, and as can be clearly seen from the language of claim 1, there is no requirement that the claimed invention comprises "sequentially stepping through each single design procedure, such as designating a primitive or inputting coordinate values..." This argument is simply not supported by the claim language.

Applicants submit similar arguments regarding claim 22, which are traversed as shown above. Applicant's arguments have been fully considered but have been found unpersuasive.

Claim Objections

8. Claim 13 is objected to because of the following informalities: claim 13 recites "sequentially reproducing sequentially reproducing unit work history data" which appears to be a typographical error. Appropriate correction is required.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. § 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. § 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. § 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was

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made in order for the examiner to consider the applicability of 35 U.S.C. § 103(c) and potential 35 U.S.C. § 102(e), (f) or (g) prior art under 35 U.S.C. § 103(a).

9. Claim 22 is rejected under 35 U.S.C. § 103(a) as being unpatentable over US Patent No. 5,552,995 to Sebastian in view of "Repairing CAD Models" by Gill Barequet et al. ("Barequet").

Regarding claim 22, Sebastian teaches a design support system [(abstract); "...*the present invention is implemented in the 'C++' programming language and uses Pro-Engineer from Parametric Technology Inc. as its solid modeling and front-end CAD system.*" (column 11, lines 21-26); "*The present invention enables a designer to create feature templates and store them in a feature template library.*" (column 13, lines 44-46)], comprising:

a database (FIG. 2, reference 34) which divides a history of design work for creating a shape model, comprising a first reference surface, for each part of the shape model and holds a plurality of design work histories as unit work history data [*"The template scheme provides a uniform data handling mechanism that spans the domain of part, tooling, process and material. The templates of the present invention allow the collection, under a single header, of various types of information: fixed parameters (e.g., user supplied data), parameters derived by relationship with other parameters from the same template (e.g., a boss' outer diameter computed from the value of its own inner diameter), parameters derived by relationship with parameters from other templates in the same domain (e.g., a boss' height computed from the thickness of the wall to which it is attached), and parameters derived by relationship with parameters from other templates in other domains (e.g., a boss' draft angle computed from the tool orientation relative to the boss).*" (column 11, lines 32-49)]; and

a control section configured to:

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fetch at least two unit work history data selected from the plurality of unit work history data held by the database [*“An example of a feature template is a “support::tapered wall” feature template, wherein the primitive object is a tapered wall and the function of the tapered wall is support. Another example is a “support::rib” feature template that represents a type of projection known as a rib, where the rib has a support function. A tapered wall and a rib can be regarded as sub-parts that can be used to make a part.”* (column 12, lines 3-11)];

combine the at least two selected unit work history data and output design work data for creating a combined shape model, comprising a second reference surface, which is formed by sequentially reproducing the unit work history data and joining part shape models corresponding to the respective unit work history data (column 12, lines 3-11; column 11, line 55 – column 12, line 3); and

create a corresponding surface group in accordance with user input of a correspondence to determine, using the corresponding surface group, errors in the combined shape model arising from the second reference surface [See column 22, *et seq.*, in particular: *“The designer starts by instantiating the nominal wall feature and uses the add-on operation to provide “Fasten” functionality. In this example, the system searches for a function template using “Fasten” as the search criteria and provides the user with the boss feature. The user specifies the parameters for the boss such as dimension and positioning information. Based on the selection, the reasoning attributes of the feature template are evaluated and the system examines the appropriate constraints. The constraints retrieve necessary additionally information from other feature templates, look-up tables and the material database 90. The constraints that pertain to the feature “boss” are evaluated, and it is found that the thickness of*

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the boss is adequate to support the applied load. However, while considering the mold fill criteria, the thickness exceeds the manufacturer's recommendation (as retrieved from the manufacturer's external database) for the selected material. Depending on the constraint evaluation results, the user is notified through one of the following mechanisms: warning messages, error messages and design change recommendations... In the boss example, the system notifies the user that the "BOSS IS TOO THICK" and recommends a range of appropriate thickness values for the selected material that satisfies both the mold fill and the strength criteria." (column 22, line 18, et seq.)].

Sebastian does not expressly teach that the errors determined using the corresponding surface group include at least one of a change of a number of configuring surfaces, a change in direction or quantity of border lines, reversal of a direction of a surface, and folding of a surface.

Barequet teaches determining errors using a corresponding surface group, the errors including at least one of a change of a number of configuring surfaces, a change in direction or quantity of border lines, reversal of a direction of a surface, and a folding of a surface [*"We describe an algorithm for repairing polyhedral CAD models that have errors in their B-REP. Errors like cracks, degeneracies, duplication, holes and overlaps are usually introduced in solid models due to imprecise arithmetic, model transformations, designer's fault, programming bugs, etc."* (Barequet, abstract); *"If the original orientation of facets is not consistent, we need to make the following modifications to our algorithm: Orient all the facets of each connected component consistently with respect to other facets in the component..."* (Barequet, page 366, "4.2 Orientation Checking"); *"The algorithm is also able to detect non-orientable surfaces while processing a "back-edge" in the depth-first order traversal. Back-edges are used to perform a*

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consistency check between two facets whose respective orientations are already fixed. If the two orientation do not match, the component is non-orientable and the system reports the error as such." (Barequet, page 365, "2 Computing the Connected Components")].

Sebastian and Barequet are analogous art because both are directed to CAD modeling.

It would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian with Barequet as expressly motivated by Barequet to identify and correct problems in the CAD model [*"File formats like IGES ... DXF ... and STL ... (which is a de facto standard in the rapid-prototyping industry) allow users to represent models as such soups of polygons... The collection of polygons is assumed to represent a complete model. Unfortunately this is often not the case. Typical problems include cracks (in the surface), degeneracies, duplication (of patches of the surface), holes and overlaps, as shown in Figure 1... We present algorithms to eliminate dangling geometry, T-joins, holes and cracks in a polygonal solid model, and generate consistent polygon-orientations.*" (Barequet, page 363, "1 Introduction")]. The combination could be achieved by using Barequet's algorithms in the system and method described by Sebastian to identify and correct the same types of errors in Sebastian's CAD models. The combination would produce a system as described by Sebastian but enhanced with the error identification and correction techniques taught by Barequet.

Therefore it would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian with Barequet to arrive at the invention specified in claim 22.

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10. Claims 1-2 and 5-21 are rejected under 35 U.S.C. § 103(a) as being unpatentable over US Patent No. 5,552,995 to Sebastian in view of US Patent No. 4,858,146 to Shebini, further in view of "Repairing CAD Models" by Gill Barequet et al. ("Barequet").

Regarding claim 1, Sebastian teaches:

A design support system [(abstract); "...*the present invention is implemented in the 'C++' programming language and uses Pro-Engineer from Parametric Technology Inc. as its solid modeling and front-end CAD system.*" (column 11, lines 21-26); "*The present invention enables a designer to create feature templates and store them in a feature template library.*" (column 13, lines 44-46)], comprising:

database (FIG. 2, reference 34) which divides a history of design work for creating a shape model, comprising a first reference surface, for each part of the shape model and holds a plurality of design work histories as unit work history data [*"The template scheme provides a uniform data handling mechanism that spans the domain of part, tooling, process and material. The templates of the present invention allow the collection, under a single header, of various types of information: fixed parameters (e.g., user supplied data), parameters derived by relationship with other parameters from the same template (e.g., a boss' outer diameter computed from the value of its own inner diameter), parameters derived by relationship with parameters from other templates in the same domain (e.g., a boss' height computed from the thickness of the wall to which it is attached), and parameters derived by relationship with parameters from other templates in other domains (e.g., a boss' draft angle computed from the tool orientation relative to the boss).*" (column 11, lines 32-49)]; and

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a control section configured to fetch at least two unit work history data selected from the plurality of unit work history data held by the database [“*An example of a feature template is a “support::tapered wall” feature template, wherein the primitive object is a tapered wall and the function of the tapered wall is support. Another example is a “support::rib” feature template that represents a type of projection known as a rib, where the rib has a support function. A tapered wall and a rib can be regarded as sub-parts that can be used to make a part.*” (column 12, lines 3-11)]; and

combine at least two selected unit work history data and output design work data for creating a combined shape model, comprising a second reference surface, which is formed by joining part shape models corresponding to the respective unit work history data (column 12, lines 3-11; column 11, line 55 – column 12, line 3);

create a corresponding surface group in accordance with user input of a correspondence (column 12, lines 3-11; column 11, line 55 – column 12, line 3); and

determine, using the corresponding surface group, errors in the combined shape model arising from the second reference surface [See column 22, *et seq.*, in particular: “*The designer starts by instantiating the nominal wall feature and uses the add-on operation to provide “Fasten” functionality. In this example, the system searches for a function template using “Fasten” as the search criteria and provides the user with the boss feature. The user specifies the parameters for the boss such as dimension and positioning information. Based on the selection, the reasoning attributes of the feature template are evaluated and the system examines the appropriate constraints. The constraints retrieve necessary additionally information from other feature templates, look-up tables and the material database 90. The constraints that*”

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pertain to the feature "boss" are evaluated, and it is found that the thickness of the boss is adequate to support the applied load. However, while considering the mold fill criteria, the thickness exceeds the manufacturer's recommendation (as retrieved from the manufacturer's external database) for the selected material. Depending on the constraint evaluation results, the user is notified through one of the following mechanisms: warning messages, error messages and design change recommendations... In the boss example, the system notifies the user that the "BOSS IS TOO THICK" and recommends a range of appropriate thickness values for the selected material that satisfies both the mold fill and the strength criteria." (column 22, line 18, et seq.)].

Sebastian does not expressly teach a database accumulating technical conditions as claimed, or that the errors determined using the corresponding surface group include the types recited by the claim.

Shebini teaches a database accumulating technical conditions, which are to be met by a part shape model to be created according to each unit work history data, in association with each unit work history data [*"Turning to very particular structures, namely off-shore platforms, we see that they must be structurally adequate for operational and environmental loading, practical to construct, and be cost effective. The selection of a configuration is based on functional requirements and methods of installation."* (Shebini, column 3, lines 60-65); *"Once environmental loads are determined, they are combined with operational loads, and an estimate is made of the resulting pile mudline moments and axial forces."* (Shebini, column 4, lines 33-39); *"Before the design solution of either the 3-dimensional "finite Element" analysis of the superstructure and jacket, or the beam-column analysis of the piling can be considered finished,*

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it is necessary to determine compatible conditions at the pilehead-structure interface. These equilibrium conditions are usually obtained using an interaction analysis procedure which yields the combined response of the linear structure and its non-linear soil-pile foundation for any imposed static load condition." (Shebini, column 4, lines 55-65); et cetera. Shebini provides numerous examples of the "technical conditions" that are accumulated in columns 3 and 4]; and

computing at least one technical characteristic value of the combined shape model which is created from the output design work data [*"The equilibrium conditions determined from the interaction analysis are now imposed on the structural Model in combination with appropriate design loads, and a static analysis is performed. The internal member forces determined in this analysis are employed to check the stress levels in the members.*" (Shebini, column 4, line 65 - column 5, line 2)]; and

comparing the computed technical characteristic value with the technical conditions related to unit work history data which is the origin of the design work data [*"The stresses are compared to allowable stresses, as set forth in the design basis, and members resized accordingly.*" (Shebini, column 5, lines 2-5)];

wherein the computation of the at least one technical characteristic value comprises analyzing the strength of the combined shape model [*"stress levels in the members"* (Shebini, column 4, line 65 - column 5, line 5)].

Sebastian and Shebini are analogous art because both are drawn to structural modeling.

It would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian and Shebini as expressly motivated by Shebini in order to predict the structural properties of the assembled product [*"Nowadays, by*

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using the Finite Element Method (FEM), stress analysts do not have to modify the problem to conform to available solutions. No matter how complex the shape or system of loads may be, the (FEM) treats a loaded structure as being built of numerous tiny connected substructures or elements as are shown in FIG. 8. Since these elements can be put together in virtually any fashion, they can be arranged in simulate exceedingly complex shapes. Thus, the (FEM) can be used to determine stresses for structural parts where no mathematically closed form solution exists." (Shebini, column 1, lines 25-35)]. The combination could be achieved by using Shebini's structural analysis method to analyze the model described by Sebastian.

Sebastian in view of Shebini does not expressly teach that the errors determined using the corresponding surface group include at least one of a change of a number of configuring surfaces, a change in direction or quantity of border lines, reversal of a direction of a surface, and folding of a surface.

Barequet teaches determining errors using a corresponding surface group, the errors including at least one of a change of a number of configuring surfaces, a change in direction or quantity of border lines, reversal of a direction of a surface, and a folding of a surface [*"We describe an algorithm for repairing polyhedral CAD models that have errors in their B-REP. Errors like cracks, degeneracies, duplication, holes and overlaps are usually introduced in solid models due to imprecise arithmetic, model transformations, designer's fault, programming bugs, etc."* (Barequet, abstract); *"If the original orientation of facets is not consistent, we need to make the following modifications to our algorithm: Orient all the facets of each connected component consistently with respect to other facets in the component..."* (Barequet, page 366, "4.2 Orientation Checking"); *"The algorithm is also able to detect non-orientable surfaces while*

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processing a "back-edge" in the depth-first order traversal. Back-edges are used to perform a consistency check between two facets whose respective orientations are already fixed. If the two orientation do not match, the component is non-orientable and the system reports the error as such." (Barequet, page 365, "2 Computing the Connected Components").

Sebastian in view of Shebini and Barequet are analogous art because both are directed to CAD modeling.

It would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian in view of Shebini with Barequet as expressly motivated by Barequet to identify and correct problems in the CAD model [*"File formats like IGES ... DXF ... and STL ... (which is a de facto standard in the rapid-prototyping industry) allow users to represent models as such soups of polygons... The collection of polygons is assumed to represent a complete model. Unfortunately this is often not the case. Typical problems include cracks (in the surface), degeneracies, duplication (of patches of the surface), holes and overlaps, as shown in Figure 1... We present algorithms to eliminate dangling geometry, T-joins, holes and cracks in a polygonal solid model, and generate consistent polygon-orientations."* (Barequet, page 363, "1 Introduction")]. The combination could be achieved by using Barequet's algorithms in the system and method described by Sebastian in view of Shebini to identify and correct the same types of errors in Sebastian's CAD models. The combination would produce a system as described by Sebastian in view of Shebini but enhanced with the error identification and correction techniques taught by Barequet.

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Therefore it would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian, Shebini, and Barequet to arrive at the invention specified in claim 1.

Regarding claim 2, Sebastian teaches:

A design support system which outputs work data for creating a shape model, comprising a first reference surface, of a design target in order to create the shape model of the design target conforming to a standard shape [(abstract); (column 11, lines 32-49)], comprising:

A database which holds a plurality of unit work history data which are obtained by dividing a history of a design work performed with reference to a first standard shape for each design work history corresponding to a shape model of a predetermined portion (column 11, lines 32-49);

A control section configured to receive designation of data about a second standard shape (FIG. 2, reference 35);

Fetch multiple unit work history data selected from the multiple unit work history data held by the database (column 12, lines 3-11); and

combine each of the fetched unit work history data, reproduce design work with reference to the designated second standard shape for the design works performed with reference to the first standard shape among the design works contained in the unit work history data, and output work data corresponding to a combined shape model, comprising a second reference surface conforming to the second standard shape [(column 11, lines 32-49); (column 11, line 55 - column 12, line 11)]; and

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create a corresponding surface group in accordance with user input of a correspondence to determine if there are errors in the combined shape model arising from the second reference surface [See column 22, *et seq.*, in particular: *"The designer starts by instantiating the nominal wall feature and uses the add-on operation to provide "Fasten" functionality. In this example, the system searches for a function template using "Fasten" as the search criteria and provides the user with the boss feature. The user specifies the parameters for the boss such as dimension and positioning information. Based on the selection, the reasoning attributes of the feature template are evaluated and the system examines the appropriate constraints. The constraints retrieve necessary additionally information from other feature templates, look-up tables and the material database 90. The constraints that pertain to the feature "boss" are evaluated, and it is found that the thickness of the boss is adequate to support the applied load. However, while considering the mold fill criteria, the thickness exceeds the manufacturer's recommendation (as retrieved from the manufacturer's external database) for the selected material. Depending on the constraint evaluation results, the user is notified through one of the following mechanisms: warning messages, error messages and design change recommendations... In the boss example, the system notifies the user that the "BOSS IS TOO THICK" and recommends a range of appropriate thickness values for the selected material that satisfies both the mold fill and the strength criteria."* (column 22, line 18, *et seq.*)].

Sebastian does not expressly teach a database accumulating technical conditions as claimed, or that the errors determined using the corresponding surface group include the types recited by the claim.

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Shebini teaches the database accumulating technical conditions, which are to be met by a part shape model to be created according to each unit work history data, in association with each unit work history data [*"Turning to very particular structures, namely off-shore platforms, we see that they must be structurally adequate for operational and environmental loading, practical to construct, and be cost effective. The selection of a configuration is based on functional requirements and methods of installation."* (Shebini, column 3, lines 60-65); *"Once environmental loads are determined, they are combined with operational loads, and an estimate is made of the resulting pile mudline moments and axial forces."* (Shebini, column 4, lines 33-39); *"Before the design solution of either the 3-dimensional "finite Element" analysis of the superstructure and jacket, or the beam-column analysis of the piling can be considered finished, it is necessary to determine compatible conditions at the pilehead-structure interface. These equilibrium conditions are usually obtained using an interaction analysis procedure which yields the combined response of the linear structure and its non-linear soil-pile foundation for any imposed static load condition."* (Shebini, column 4, lines 55-65); et cetera. Shebini provides numerous examples of the "technical conditions" that are accumulated in columns 3 and 4];

computing at least one technical characteristic value of the combined shape model which is created from the output work data [*"The equilibrium conditions determined from the interaction analysis are now imposed on the structural Model in combination with appropriate design loads, and a static analysis is performed. The internal member forces determined in this analysis are employed to check the stress levels in the members."* (Shebini, column 4, line 65 - column 5, line 2)]; and

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compare the computed technical characteristic value with technical conditions related to unit work history data which is the origin of the work data [*"The stresses are compared to allowable stresses, as set forth in the design basis, and members resized accordingly."* (Shebini, column 5, lines 2-5)];

wherein the computation of the at least one technical characteristic value comprises analyzing the strength of the combined shape model [*"stress levels in the members"* (Shebini, column 4, line 65 - column 5, line 5)].

Sebastian and Shebini are analogous art because both are drawn to structural modeling.

It would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian and Shebini as expressly motivated by Shebini in order to predict the structural properties of the assembled product [*"Nowadays, by using the Finite Element Method (FEM), stress analysts do not have to modify the problem to conform to available solutions. No matter how complex the shape or system of loads may be, the (FEM) treats a loaded structure as being built of numerous tiny connected substructures or elements as are shown in FIG. 8. Since these elements can be put together in virtually any fashion, they can be arranged in simulate exceedingly complex shapes. Thus, the (FEM) can be used to determine stresses for structural parts where no mathematically closed form solution exists."* (Shebini, column 1, lines 25-35)]. The combination could be achieved by using Shebini's structural analysis method to analyze the model described by Sebastian.

Sebastian in view of Shebini that the errors determined using the corresponding surface group include the types recited by the claim.

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Barequet teaches determining errors using a corresponding surface group, the errors including at least one of a change of a number of configuring surfaces, a change in direction or quantity of border lines, reversal of a direction of a surface, and a folding of a surface [*"We describe an algorithm for repairing polyhedral CAD models that have errors in their B-REP. Errors like cracks, degeneracies, duplication, holes and overlaps are usually introduced in solid models due to imprecise arithmetic, model transformations, designer's fault, programming bugs, etc."* (Barequet, abstract); *"If the original orientation of facets is not consistent, we need to make the following modifications to our algorithm: Orient all the facets of each connected component consistently with respect to other facets in the component..."* (Barequet, page 366, "4.2 Orientation Checking"); *"The algorithm is also able to detect non-orientable surfaces while processing a "back-edge" in the depth-first order traversal. Back-edges are used to perform a consistency check between two facets whose respective orientations are already fixed. If the two orientation do not match, the component is non-orientable and the system reports the error as such."* (Barequet, page 365, "2 Computing the Connected Components")].

Sebastian in view of Shebini and Barequet are analogous art because both are directed to CAD modeling.

It would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian in view of Shebini with Barequet as expressly motivated by Barequet to identify and correct problems in the CAD model [*"File formats like IGES ... DXF ... and STL ... (which is a de facto standard in the rapid-prototyping industry) allow users to represent models as such soups of polygons... The collection of polygons is assumed to represent a complete model. Unfortunately this is often not the case. Typical*

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problems include cracks (in the surface), degeneracies, duplication (of patches of the surface), holes and overlaps, as shown in Figure 1... We present algorithms to eliminate dangling geometry, T-joins, holes and cracks in a polygonal solid model, and generate consistent polygon-orientations." (Barequet, page 363, "1 Introduction")]. The combination could be achieved by using Barequet's algorithms in the system and method described by Sebastian in view of Shebini to identify and correct the same types of errors in Sebastian's CAD models. The combination would produce a system as described by Sebastian in view of Shebini but enhanced with the error identification and correction techniques taught by Barequet.

Therefore it would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian, Shebini, and Barequet to arrive at the invention specified in claim 2.

Regarding claim 5, Sebastian teaches:

The design support system according to claim 2, wherein the control section is further configured to receive designation of data about a third standard shape (FIG. 2, reference 35); wherein:

The work data is converted by reproducing a design work with reference to the designated third standard shape for work included in the work contained in the output work data and performed with reference to the second standard shape, and converted work data corresponding to a shape model conforming to the third standard shape is output [(column 11, lines 32-49); (column 12, lines 3-11)].

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Regarding claim 6, Sebastian teaches:

The design support system according to claim 1, wherein the control section is further configured to analyze the history of design work and extract input work carried out by a person in charge of work when unit historical data is created [*“CreateT... creates a new template...”* (column 21, lines 50-55, etc.)]; and the design support system further including:

A display section which shows the extracted input work to the person in charge of work to request input of design support information [*“In this example, the system searches for a function template using “Fasten” as the search criteria and provides the user with the boss feature.”* (column 22, lines 21-28); *“At any time the user has the ability to modify the feature attribute values and the system processes the effect of these changes...”* (column 22, lines 57-65)]; and

A database which records the design support information in a history of the design work and divides the history of the design work into unit historical data when the design support information is input so to show when the design support information is reused (column 22, lines 41-65).

Regarding claim 7, Sebastian teaches:

A design support system which holds a series of design work histories to reuse as work history data and creates a shape based on the work history data [(abstract); (column 11, lines 32-49); (column 12, lines 3-11)], comprising:

A control section which analyzes the work history data, comprising a first reference surface, by sequentially reproducing unit work history data to extract input work, comprising a

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second reference surface, carried out by a person in charge of work [(column 11, lines 32-49), (column 21, lines 50-55, etc.)];

creates a corresponding surface group in accordance with user input of a correspondence and determines, using the corresponding surface group, errors in the extracted input work arising from the second reference surface [See column 22, *et seq.*, in particular: *"The designer starts by instantiating the nominal wall feature and uses the add-on operation to provide "Fasten" functionality. In this example, the system searches for a function template using "Fasten" as the search criteria and provides the user with the boss feature. The user specifies the parameters for the boss such as dimension and positioning information. Based on the selection, the reasoning attributes of the feature template are evaluated and the system examines the appropriate constraints. The constraints retrieve necessary additionally information from other feature templates, look-up tables and the material database 90. The constraints that pertain to the feature "boss" are evaluated, and it is found that the thickness of the boss is adequate to support the applied load. However, while considering the mold fill criteria, the thickness exceeds the manufacturer's recommendation (as retrieved from the manufacturer's external database) for the selected material. Depending on the constraint evaluation results, the user is notified through one of the following mechanisms: warning messages, error messages and design change recommendations... In the boss example, the system notifies the user that the "BOSS IS TOO THICK" and recommends a range of appropriate thickness values for the selected material that satisfies both the mold fill and the strength criteria."* (column 22, line 18, *et seq.*)].

A display section which shows the extracted input work to the person in charge of work to request input of design support information (column 22, lines 21-65); and

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A database which records the design support information in the work history data when the design support information is input so to show when the design support information is reused (column 22, lines 41-65).

Sebastian does not expressly teach a database accumulating technical conditions as claimed, or that the errors detected using the corresponding surface group include the types recited by the claim.

Shebini teaches the database accumulating technical conditions, which are to be met by the shape created based on the work history data, in association with the work history data [*"Turning to very particular structures, namely off-shore platforms, we see that they must be structurally adequate for operational and environmental loading, practical to construct, and be cost effective. The selection of a configuration is based on functional requirements and methods of installation."* (Shebini, column 3, lines 60-65); *"Once environmental loads are determined, they are combined with operational loads, and an estimate is made of the resulting pile mudline moments and axial forces."* (Shebini, column 4, lines 33-39); *"Before the design solution of either the 3-dimensional 'finite Element' analysis of the superstructure and jacket, or the beam-column analysis of the piling can be considered finished, it is necessary to determine compatible conditions at the pilehead-structure interface. These equilibrium conditions are usually obtained using an interaction analysis procedure which yields the combined response of the linear structure and its non-linear soil-pile foundation for any imposed static load condition."* (Shebini, column 4, lines 55-65); et cetera. Shebini provides numerous examples of the "technical conditions" that are accumulated in columns 3 and 4];

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computing at least one technical characteristic value of the shape which is created based on the work history data [*"The equilibrium conditions determined from the interaction analysis are now imposed on the structural Model in combination with appropriate design loads, and a static analysis is performed. The internal member forces determined in this analysis are employed to check the stress levels in the members."* (Shebini, column 4, line 65 - column 5, line 2)]; and

comparing the computed technical characteristic value with technical conditions related to work history data which is the origin of the work data [*"The stresses are compared to allowable stresses, as set forth in the design basis, and members resized accordingly."* (Shebini, column 5, lines 2-5)];

wherein the computation of the at least one technical characteristic value comprises analyzing the strength of the shape [*"stress levels in the members"* (Shebini, column 4, line 65 - column 5, line 5)].

Sebastian and Shebini are analogous art because both are drawn to structural modeling.

It would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian and Shebini as expressly motivated by Shebini in order to predict the structural properties of the assembled product [*"Nowadays, by using the Finite Element Method (FEM), stress analysts do not have to modify the problem to conform to available solutions. No matter how complex the shape or system of loads may be, the (FEM) treats a loaded structure as being built of numerous tiny connected substructures or elements as are shown in FIG. 8. Since these elements can be put together in virtually any fashion, they can be arranged in simulate exceedingly complex shapes. Thus, the (FEM) can be*

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used to determine stresses for structural parts where no mathematically closed form solution exists." (Shebini, column 1, lines 25-35)]. The combination could be achieved by using Shebini's structural analysis method to analyze the model described by Sebastian.

Sebastian in view of Shebini does not expressly that the errors determined using the corresponding surface group include the types recited by the claim.

Barequet teaches determining errors using a corresponding surface group, the errors including at least one of a change of a number of configuring surfaces, a change in direction or quantity of border lines, reversal of a direction of a surface, and a folding of a surface [*"We describe an algorithm for repairing polyhedral CAD models that have errors in their B-REP. Errors like cracks, degeneracies, duplication, holes and overlaps are usually introduced in solid models due to imprecise arithmetic, model transformations, designer's fault, programming bugs, etc."* (Barequet, abstract); *"If the original orientation of facets is not consistent, we need to make the following modifications to our algorithm: Orient all the facets of each connected component consistently with respect to other facets in the component..."* (Barequet, page 366, "4.2 Orientation Checking"); *"The algorithm is also able to detect non-orientable surfaces while processing a "back-edge" in the depth-first order traversal. Back-edges are used to perform a consistency check between two facets whose respective orientations are already fixed. If the two orientation do not match, the component is non-orientable and the system reports the error as such."* (Barequet, page 365, "2 Computing the Connected Components")].

Sebastian in view of Shebini and Barequet are analogous art because both are directed to CAD modeling.

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It would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian in view of Shebini with Barequet as expressly motivated by Barequet to identify and correct problems in the CAD model [*"File formats like IGES ... DXF ... and STL ... (which is a de facto standard in the rapid-prototyping industry) allow users to represent models as such soups of polygons... The collection of polygons is assumed to represent a complete model. Unfortunately this is often not the case. Typical problems include cracks (in the surface), degeneracies, duplication (of patches of the surface), holes and overlaps, as shown in Figure 1... We present algorithms to eliminate dangling geometry, T-joins, holes and cracks in a polygonal solid model, and generate consistent polygon-orientations."* (Barequet, page 363, "1 Introduction")]. The combination could be achieved by using Barequet's algorithms in the system and method described by Sebastian in view of Shebini to identify and correct the same types of errors in Sebastian's CAD models. The combination would produce a system as described by Sebastian in view of Shebini but enhanced with the error identification and correction techniques taught by Barequet.

Therefore it would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian, Shebini, and Barequet to arrive at the invention specified in claim 7.

Regarding claim 8, Sebastian teaches:

The design support system according to claim 7, wherein the database is further configured to generate unit work history data by dividing the work history data into predetermined work units for a design target (column 21, lines 50-55, etc.).

Regarding claim 9, Sebastian teaches:

A design support system (abstract), comprising:

A database which accumulates unit work history data which is formed by dividing a history of past design work, comprising a first reference surface, into work units determined for a design target and contains design support information related to input work among the design work [(column 11, lines 32-49); (column 12, lines 3-11)];

A control section configured to selectively show the unit work history on a display section upon receiving designation of the design target [(column 22, lines 21-65) alternatively (column 16, lines 19-47)];

Create a shape comprising a second reference surface by sequentially reproducing the selected unit work history [(column 11, lines 32-49); (column 12, lines 3-11)];

Provide design support information related to input work when the input work is demanded while the unit work history is being reproduced [(column 22, lines 21-65) alternatively (column 16, lines 19-47)];

create a corresponding surface group in accordance with user input of a correspondence, and determine, using the corresponding surface group, errors in the shape arising from the second reference surface [See column 22, *et seq.*, in particular: *"The designer starts by instantiating the nominal wall feature and uses the add-on operation to provide "Fasten" functionality. In this example, the system searches for a function template using "Fasten" as the search criteria and provides the user with the boss feature. The user specifies the parameters for the boss such as dimension and positioning information. Based on the selection, the reasoning*

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attributes of the feature template are evaluated and the system examines the appropriate constraints. The constraints retrieve necessary additionally information from other feature templates, look-up tables and the material database 90. The constraints that pertain to the feature "boss" are evaluated, and it is found that the thickness of the boss is adequate to support the applied load. However, while considering the mold fill criteria, the thickness exceeds the manufacturer's recommendation (as retrieved from the manufacturer's external database) for the selected material. Depending on the constraint evaluation results, the user is notified through one of the following mechanisms: warning messages, error messages and design change recommendations... In the boss example, the system notifies the user that the "BOSS IS TOO THICK" and recommends a range of appropriate thickness values for the selected material that satisfies both the mold fill and the strength criteria." (column 22, line 18, et seq.)].

Sebastian does not expressly teach a database accumulating technical conditions as claimed, or that the errors determined using the corresponding surface group include the types recited by the claim.

Shebini teaches the database accumulating technical conditions, which are to be met by the part shape model to be created based on each work history data, in association with each work history data [*"Turning to very particular structures, namely off-shore platforms, we see that they must be structurally adequate for operational and environmental loading, practical to construct, and be cost effective. The selection of a configuration is based on functional requirements and methods of installation."* (Shebini, column 3, lines 60-65); *"Once environmental loads are determined, they are combined with operational loads, and an estimate is made of the resulting pile mudline moments and axial forces."* (Shebini, column 4, lines 33-

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39); *"Before the design solution of either the 3-dimensional "finite Element" analysis of the superstructure and jacket, or the beam-column analysis of the piling can be considered finished, it is necessary to determine compatible conditions at the pilehead-structure interface. These equilibrium conditions are usually obtained using an interaction analysis procedure which yields the combined response of the linear structure and its non-linear soil-pile foundation for any imposed static load condition."* (Shebini, column 4, lines 55-65); et cetera. Shebini provides numerous examples of the "technical conditions" that are accumulated in columns 3 and 4];

computing at least one technical characteristic value of the shape which is created based on the work history data [*"The equilibrium conditions determined from the interaction analysis are now imposed on the structural Model in combination with appropriate design loads, and a static analysis is performed. The internal member forces determined in this analysis are employed to check the stress levels in the members."* (Shebini, column 4, line 65 - column 5, line 2)]; and

comparing the computed technical characteristic value with technical conditions related to work history data which is the origin of the work data [*"The stresses are compared to allowable stresses, as set forth in the design basis, and members resized accordingly."* (Shebini, column 5, lines 2-5)];

wherein the computation of the at least one technical characteristic value comprises analyzing the strength of the shape [*"stress levels in the members"* (Shebini, column 4, line 65 - column 5, line 5)].

Sebastian and Shebini are analogous art because both are drawn to structural modeling.

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It would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian and Shebini as expressly motivated by Shebini in order to predict the structural properties of the assembled product [*"Nowadays, by using the Finite Element Method (FEM), stress analysts do not have to modify the problem to conform to available solutions. No matter how complex the shape or system of loads may be, the (FEM) treats a loaded structure as being built of numerous tiny connected substructures or elements as are shown in FIG. 8. Since these elements can be put together in virtually any fashion, they can be arranged in simulate exceedingly complex shapes. Thus, the (FEM) can be used to determine stresses for structural parts where no mathematically closed form solution exists."* (Shebini, column 1, lines 25-35)]. The combination could be achieved by using Shebini's structural analysis method to analyze the model described by Sebastian.

Sebastian in view of Shebini does not expressly teach that the errors determined using the corresponding surface group include the types recited by the claim.

Barequet teaches determining errors using a corresponding surface group, the errors including at least one of a change of a number of configuring surfaces, a change in direction or quantity of border lines, reversal of a direction of a surface, and a folding of a surface [*"We describe an algorithm for repairing polyhedral CAD models that have errors in their B-REP. Errors like cracks, degeneracies, duplication, holes and overlaps are usually introduced in solid models due to imprecise arithmetic, model transformations, designer's fault, programming bugs, etc."* (Barequet, abstract); *"If the original orientation of facets is not consistent, we need to make the following modifications to our algorithm: Orient all the facets of each connected component consistently with respect to other facets in the component..."* (Barequet, page 366, "4.2

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Orientation Checking"); *"The algorithm is also able to detect non-orientable surfaces while processing a "back-edge" in the depth-first order traversal. Back-edges are used to perform a consistency check between two facets whose respective orientations are already fixed. If the two orientation do not match, the component is non-orientable and the system reports the error as such."* (Barequet, page 365, "2 Computing the Connected Components")].

Sebastian in view of Shebini and Barequet are analogous art because both are directed to CAD modeling.

It would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian in view of Shebini with Barequet as expressly motivated by Barequet to identify and correct problems in the CAD model [*"File formats like IGES ... DXF ... and STL ... (which is a de facto standard in the rapid-prototyping industry) allow users to represent models as such soups of polygons... The collection of polygons is assumed to represent a complete model. Unfortunately this is often not the case. Typical problems include cracks (in the surface), degeneracies, duplication (of patches of the surface), holes and overlaps, as shown in Figure 1... We present algorithms to eliminate dangling geometry, T-joins, holes and cracks in a polygonal solid model, and generate consistent polygon-orientations."* (Barequet, page 363, "1 Introduction")]. The combination could be achieved by using Barequet's algorithms in the system and method described by Sebastian in view of Shebini to identify and correct the same types of errors in Sebastian's CAD models. The combination would produce a system as described by Sebastian in view of Shebini but enhanced with the error identification and correction techniques taught by Barequet.

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Therefore it would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian, Shebini, and Barequet to arrive at the invention specified in claim 9.

Regarding claim 10, Sebastian teaches:

The design support system according to claim 9, wherein the control section is further configured to judge whether the work history to be reproduced agrees with predetermined guidance display conditions while the unit work history is being reproduced (column 22, lines 21-65); and wherein

The display section is further configured to implement a guidance display determined in connection with the guide display conditions if the work history agrees with the guidance display conditions (column 22, lines 21-65).

Regarding claim 11, Sebastian teaches:

A database which accumulates unit work history data which is formed by dividing a history of past design work into work units, comprising a first reference surface, determined for a design target and contains design support information related to an input work among the design work [(abstract); (column 11, lines 32-49); (column 12, lines 3-11)];

A first display device which shows a shape, comprising a second reference surface, of the design target obtained by sequentially reproducing a history of the design work with reference to the unit work history data [*“The representative embodiment supports, amongst others, the*

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following interfaces: to CAD systems – IGES, Pro-Engineer and IDEAS; for FEM structural analysis – PATRAN/NASTRAN and IDEAS; for FEM molding filling, cooling and shrinkage analysis – C-FLOW, IDEAS, Moldflow and TMC; and for tool design – IDEAS, Pro-Engineer and DME Moldbase Catalog.” (column 18, lines 35-41)];

A second display device which shows design support information contained in the unit work history data by reproducing a history of the design work prior to the reproduction at the first display device [(column 18, lines 35-41); (column 11, lines 21-26)]; and

a control section which creates a corresponding surface group in accordance with user input of a correspondence, and determines, using the corresponding surface group, errors in the shape arising from the second reference surface [See column 22, *et seq.*, in particular: *"The designer starts by instantiating the nominal wall feature and uses the add-on operation to provide "Fasten" functionality. In this example, the system searches for a function template using "Fasten" as the search criteria and provides the user with the boss feature. The user specifies the parameters for the boss such as dimension and positioning information. Based on the selection, the reasoning attributes of the feature template are evaluated and the system examines the appropriate constraints. The constraints retrieve necessary additionally information from other feature templates, look-up tables and the material database 90. The constraints that pertain to the feature "boss" are evaluated, and it is found that the thickness of the boss is adequate to support the applied load. However, while considering the mold fill criteria, the thickness exceeds the manufacturer's recommendation (as retrieved from the manufacturer's external database) for the selected material. Depending on the constraint evaluation results, the user is notified through one of the following mechanisms: warning*

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messages, error messages and design change recommendations... In the boss example, the system notifies the user that the "BOSS IS TOO THICK" and recommends a range of appropriate thickness values for the selected material that satisfies both the mold fill and the strength criteria." (column 22, line 18, et seq.)].

Sebastian does not expressly teach a database accumulating technical conditions as claimed, or that the errors determined using the corresponding surface group include the types recited by the claim.

Shebini teaches the database accumulating technical conditions, which are to be met by the part shape model to be created based on each work history data, in association with each work history data [*"Turning to very particular structures, namely off-shore platforms, we see that they must be structurally adequate for operational and environmental loading, practical to construct, and be cost effective. The selection of a configuration is based on functional requirements and methods of installation." (Shebini, column 3, lines 60-65); "Once environmental loads are determined, they are combined with operational loads, and an estimate is made of the resulting pile mudline moments and axial forces." (Shebini, column 4, lines 33-39); "Before the design solution of either the 3-dimensional "finite Element" analysis of the superstructure and jacket, or the beam-column analysis of the piling can be considered finished, it is necessary to determine compatible conditions at the pilehead-structure interface. These equilibrium conditions are usually obtained using an interaction analysis procedure which yields the combined response of the linear structure and its non-linear soil-pile foundation for nay*

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imposed static load condition." (Shebini, column 4, lines 55-65); et cetera. Shebini provides numerous examples of the "technical conditions" that are accumulated in columns 3 and 4];

computing at least one technical characteristic value of the shape which is created based on the work history data [*"The equilibrium conditions determined from the interaction analysis are now imposed on the structural Model in combination with appropriate design loads, and a static analysis is performed. The internal member forces determined in this analysis are employed to check the stress levels in the members."* (Shebini, column 4, line 65 - column 5, line 2)]; and

comparing the computed technical characteristic value with technical conditions related to work history data which is the origin of the work data [*"The stresses are compared to allowable stresses, as set forth in the design basis, and members resized accordingly."* (Shebini, column 5, lines 2-5)];

wherein the computation of the at least one technical characteristic value comprises analyzing the strength of the shape [*"stress levels in the members"* (Shebini, column 4, line 65 - column 5, line 5)].

Sebastian and Shebini are analogous art because both are drawn to structural modeling.

It would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian and Shebini as expressly motivated by Shebini in order to predict the structural properties of the assembled product [*"Nowadays, by using the Finite Element Method (FEM), stress analysts do not have to modify the problem to conform to available solutions. No matter how complex the shape or system of loads may be, the (FEM) treats a loaded structure as being built of numerous tiny connected substructures or*

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elements as are shown in FIG. 8. Since these elements can be put together in virtually any fashion, they can be arranged in simulate exceedingly complex shapes. Thus, the (FEM) can be used to determine stresses for structural parts where no mathematically closed form solution exists." (Shebini, column 1, lines 25-35)]. The combination could be achieved by using Shebini's structural analysis method to analyze the model described by Sebastian.

Sebastian in view of Shebini does not expressly teach that the errors determined using the corresponding surface group include the types recited by the claim.

Barequet teaches determining errors using a corresponding surface group, the errors including at least one of a change of a number of configuring surfaces, a change in direction or quantity of border lines, reversal of a direction of a surface, and a folding of a surface [*"We describe an algorithm for repairing polyhedral CAD models that have errors in their B-REP. Errors like cracks, degeneracies, duplication, holes and overlaps are usually introduced in solid models due to imprecise arithmetic, model transformations, designer's fault, programming bugs, etc."* (Barequet, abstract); *"If the original orientation of facets is not consistent, we need to make the following modifications to our algorithm: Orient all the facets of each connected component consistently with respect to other facets in the component..."* (Barequet, page 366, "4.2 Orientation Checking"); *"The algorithm is also able to detect non-orientable surfaces while processing a "back-edge" in the depth-first order traversal. Back-edges are used to perform a consistency check between two facets whose respective orientations are already fixed. If the two orientation do not match, the component is non-orientable and the system reports the error as such."* (Barequet, page 365, "2 Computing the Connected Components")].

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Sebastian in view of Shebini and Barequet are analogous art because both are directed to CAD modeling.

It would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian in view of Shebini with Barequet as expressly motivated by Barequet to identify and correct problems in the CAD model [*"File formats like IGES ... DXF ... and STL ... (which is a de facto standard in the rapid-prototyping industry) allow users to represent models as such soups of polygons... The collection of polygons is assumed to represent a complete model. Unfortunately this is often not the case. Typical problems include cracks (in the surface), degeneracies, duplication (of patches of the surface), holes and overlaps, as shown in Figure 1... We present algorithms to eliminate dangling geometry, T-joins, holes and cracks in a polygonal solid model, and generate consistent polygon-orientations."* (Barequet, page 363, "1 Introduction")]. The combination could be achieved by using Barequet's algorithms in the system and method described by Sebastian in view of Shebini to identify and correct the same types of errors in Sebastian's CAD models. The combination would produce a system as described by Sebastian in view of Shebini but enhanced with the error identification and correction techniques taught by Barequet.

Therefore it would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian, Shebini, and Barequet to arrive at the invention specified in claim 11.

Regarding claim 12, Sebastian teaches:

A design support method using a computer, wherein:

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A series of design work histories is held in multiple quantities as work history data, comprising a first reference surface in a database in order to create a part shape model [(abstract); (column 11, lines 32-49); (column 12, lines 3-11); (column 13, lines 44-46)];

At least two selected history data are fetched from the held multiple work history data according to an instruction input to a processor (column 22, lines 21-65); and

Design work data for creating a one-piece shape model comprising a second reference surface by sequentially reproducing unit work history data and combining the at least two fetched work history data and connecting part shape models corresponding to the respective work history data is output (column 11, line 32 - column 12, line 11); and

a corresponding surface group is created by a control section in accordance with user input of a correspondence, errors in the one-piece shape model arising from the second reference surface are determined, using the corresponding surface group, by the control section [See column 22, *et seq.*, in particular: *"The designer starts by instantiating the nominal wall feature and uses the add-on operation to provide "Fasten" functionality. In this example, the system searches for a function template using "Fasten" as the search criteria and provides the user with the boss feature. The user specifies the parameters for the boss such as dimension and positioning information. Based on the selection, the reasoning attributes of the feature template are evaluated and the system examines the appropriate constraints. The constraints retrieve necessary additionally information from other feature templates, look-up tables and the material database 90. The constraints that pertain to the feature "boss" are evaluated, and it is found that the thickness of the boss is adequate to support the applied load. However, while considering the mold fill criteria, the thickness exceeds the manufacturer's recommendation (as retrieved*

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from the manufacturer's external database) for the selected material. Depending on the constraint evaluation results, the user is notified through one of the following mechanisms: warning messages, error messages and design change recommendations... In the boss example, the system notifies the user that the "BOSS IS TOO THICK" and recommends a range of appropriate thickness values for the selected material that satisfies both the mold fill and the strength criteria." (column 22, line 18, et seq.)].

Sebastian does not expressly teach a database accumulating technical conditions as claimed, or that the errors determined using the corresponding surface group include the types recited by the claim.

Shebini teaches the database accumulating technical conditions, which are to be met by the part shape model to be created according to each work history data, in association with each work history data [*"Turning to very particular structures, namely off-shore platforms, we see that they must be structurally adequate for operational and environmental loading, practical to construct, and be cost effective. The selection of a configuration is based on functional requirements and methods of installation."* (Shebini, column 3, lines 60-65); *"Once environmental loads are determined, they are combined with operational loads, and an estimate is made of the resulting pile mudline moments and axial forces."* (Shebini, column 4, lines 33-39); *"Before the design solution of either the 3-dimensional "finite Element" analysis of the superstructure and jacket, or the beam-column analysis of the piling can be considered finished, it is necessary to determine compatible conditions at the pilehead-structure interface. These equilibrium conditions are usually obtained using an interaction analysis procedure which yields*

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the combined response of the linear structure and its non-linear soil-pile foundation for any imposed static load condition." (Shebini, column 4, lines 55-65); et cetera. Shebini provides numerous examples of the "technical conditions" that are accumulated in columns 3 and 4];

computing at least one technical characteristic value of the one-piece shape model which is created based on the work history data [*"The equilibrium conditions determined from the interaction analysis are now imposed on the structural Model in combination with appropriate design loads, and a static analysis is performed. The internal member forces determined in this analysis are employed to check the stress levels in the members."* (Shebini, column 4, line 65 - column 5, line 2)]; and

comparing the computed technical characteristic value with technical conditions related to work history data which is the origin of the design work data [*"The stresses are compared to allowable stresses, as set forth in the design basis, and members resized accordingly."* (Shebini, column 5, lines 2-5)];

wherein the computation of the at least one technical characteristic value comprises analyzing the strength of the one-piece shape model [*"stress levels in the members"* (Shebini, column 4, line 65 - column 5, line 5)].

Sebastian and Shebini are analogous art because both are drawn to structural modeling.

It would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian and Shebini as expressly motivated by Shebini in order to predict the structural properties of the assembled product [*"Nowadays, by using the Finite Element Method (FEM), stress analysts do not have to modify the problem to conform to available solutions. No matter how complex the shape or system of loads may be,*

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the (FEM) treats a loaded structure as being built of numerous tiny connected substructures or elements as are shown in FIG. 8. Since these elements can be put together in virtually any fashion, they can be arranged in simulate exceedingly complex shapes. Thus, the (FEM) can be used to determine stresses for structural parts where no mathematically closed form solution exists." (Shebini, column 1, lines 25-35)]. The combination could be achieved by using Shebini's structural analysis method to analyze the model described by Sebastian.

Sebastian in view of Shebini does not expressly teach that the errors determined using the corresponding surface group include the types recited by the claim.

Barequet teaches determining errors using a corresponding surface group, the errors including at least one of a change of a number of configuring surfaces, a change in direction or quantity of border lines, reversal of a direction of a surface, and a folding of a surface [*"We describe an algorithm for repairing polyhedral CAD models that have errors in their B-REP. Errors like cracks, degeneracies, duplication, holes and overlaps are usually introduced in solid models due to imprecise arithmetic, model transformations, designer's fault, programming bugs, etc."* (Barequet, abstract); *"If the original orientation of facets is not consistent, we need to make the following modifications to our algorithm: Orient all the facets of each connected component consistently with respect to other facets in the component..."* (Barequet, page 366, "4.2 Orientation Checking"); *"The algorithm is also able to detect non-orientable surfaces while processing a "back-edge" in the depth-first order traversal. Back-edges are used to perform a consistency check between two facets whose respective orientations are already fixed. If the two orientation do not match, the component is non-orientable and the system reports the error as such."* (Barequet, page 365, "2 Computing the Connected Components")].

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It would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian in view of Shebini with Barequet as expressly motivated by Barequet to identify and correct problems in the CAD model [*"File formats like IGES ... DXF ... and STL ... (which is a de facto standard in the rapid-prototyping industry) allow users to represent models as such soups of polygons... The collection of polygons is assumed to represent a complete model. Unfortunately this is often not the case. Typical problems include cracks (in the surface), degeneracies, duplication (of patches of the surface), holes and overlaps, as shown in Figure 1... We present algorithms to eliminate dangling geometry, T-joins, holes and cracks in a polygonal solid model, and generate consistent polygon-orientations."* (Barequet, page 363, "1 Introduction")]. The combination could be achieved by using Barequet's algorithms in the system and method described by Sebastian in view of Shebini to identify and correct the same types of errors in Sebastian's CAD models. The combination would produce a system as described by Sebastian in view of Shebini but enhanced with the error identification and correction techniques taught by Barequet.

Therefore it would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian, Shebini, and Barequet to arrive at the invention specified in claim 12.

Regarding claim 13, Sebastian teaches:

A design support method which uses a computer to create a shape model of a design target conforming to a desired standard shape according to input to its processor and outputs

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work data for creating the shape model of the design target [(abstract); (column 11, lines 32-49); (column 12, lines 3-11); (column 13, lines 44-46)], comprising the steps of:

Holding a plurality of histories of design work performed in the past with reference to the respective standard shapes, comprising a first reference surface, in a database as work history data (column 13, lines 44-46);

Accepting designation of data about a second standard shape, which is a desired standard shape, according to an instruction input to the processor (column 22, lines 21-65);

Fetching the selected multiple work history data from the multiple work history data held in the database (column 22, lines 21-65); and

Combining respective pieces of the fetched work history data, sequentially reproducing sequentially reproducing unit work history data, reproducing design work with reference to the designated second standard shape for the design work performed in the past with reference to the respective standard shapes among the design work contained in the work history data, and outputting work data corresponding to a combined shape model conforming to the second standard shape (column 12, lines 3-11); and

creating a corresponding surface group and determining, using the corresponding surface group, errors in the combined shape model arising from the second reference surface [See column 22, *et seq.*, in particular: *"The designer starts by instantiating the nominal wall feature and uses the add-on operation to provide "Fasten" functionality. In this example, the system searches for a function template using "Fasten" as the search criteria and provides the user with the boss feature. The user specifies the parameters for the boss such as dimension and positioning information. Based on the selection, the reasoning attributes of the feature template*

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are evaluated and the system examines the appropriate constraints. The constraints retrieve necessary additionally information from other feature templates, look-up tables and the material database 90. The constraints that pertain to the feature "boss" are evaluated, and it is found that the thickness of the boss is adequate to support the applied load. However, while considering the mold fill criteria, the thickness exceeds the manufacturer's recommendation (as retrieved from the manufacturer's external database) for the selected material. Depending on the constraint evaluation results, the user is notified through one of the following mechanisms: warning messages, error messages and design change recommendations... In the boss example, the system notifies the user that the "BOSS IS TOO THICK" and recommends a range of appropriate thickness values for the selected material that satisfies both the mold fill and the strength criteria." (column 22, line 18, et seq.)].

Sebastian does not expressly teach a database accumulating technical conditions as claimed, or that the errors determined using the corresponding surface group include the types recited by the claim.

Shebini teaches the database accumulating technical conditions, which are to be met by the part shape model to be created according to each work history data, in association with each work history data [*"Turning to very particular structures, namely off-shore platforms, we see that they must be structurally adequate for operational and environmental loading, practical to construct, and be cost effective. The selection of a configuration is based on functional requirements and methods of installation."* (Shebini, column 3, lines 60-65); *"Once environmental loads are determined, they are combined with operational loads, and an estimate is made of the resulting pile mudline moments and axial forces."* (Shebini, column 4, lines 33-

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39); *"Before the design solution of either the 3-dimensional "finite Element" analysis of the superstructure and jacket, or the beam-column analysis of the piling can be considered finished, it is necessary to determine compatible conditions at the pilehead-structure interface. These equilibrium conditions are usually obtained using an interaction analysis procedure which yields the combined response of the linear structure and its non-linear soil-pile foundation for any imposed static load condition."* (Shebini, column 4, lines 55-65); et cetera. Shebini provides numerous examples of the "technical conditions" that are accumulated in columns 3 and 4];

computing at least one technical characteristic value of the one-piece shape model which is created based on the fetched work history data [*"The equilibrium conditions determined from the interaction analysis are now imposed on the structural Model in combination with appropriate design loads, and a static analysis is performed. The internal member forces determined in this analysis are employed to check the stress levels in the members."* (Shebini, column 4, line 65 - column 5, line 2)]; and

comparing the computed technical characteristic value with technical conditions related to work history data which is the origin of the design work data [*"The stresses are compared to allowable stresses, as set forth in the design basis, and members resized accordingly."* (Shebini, column 5, lines 2-5)];

wherein the computation of the at least one technical characteristic value comprises analyzing the strength of the one-piece shape model [*"stress levels in the members"* (Shebini, column 4, line 65 - column 5, line 5)].

Sebastian and Shebini are analogous art because both are drawn to structural modeling.

It would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian and Shebini as expressly motivated by Shebini in order to predict the structural properties of the assembled product [*"Nowadays, by using the Finite Element Method (FEM), stress analysts do not have to modify the problem to conform to available solutions. No matter how complex the shape or system of loads may be, the (FEM) treats a loaded structure as being built of numerous tiny connected substructures or elements as are shown in FIG. 8. Since these elements can be put together in virtually any fashion, they can be arranged in simulate exceedingly complex shapes. Thus, the (FEM) can be used to determine stresses for structural parts where no mathematically closed form solution exists."* (Shebini, column 1, lines 25-35)]. The combination could be achieved by using Shebini's structural analysis method to analyze the model described by Sebastian.

Sebastian in view of Shebini does not expressly teach that the errors determined using the corresponding surface group include the types recited by the claim.

Barequet teaches determining errors using a corresponding surface group, the errors including at least one of a change of a number of configuring surfaces, a change in direction or quantity of border lines, reversal of a direction of a surface, and a folding of a surface [*"We describe an algorithm for repairing polyhedral CAD models that have errors in their B-REP. Errors like cracks, degeneracies, duplication, holes and overlaps are usually introduced in solid models due to imprecise arithmetic, model transformations, designer's fault, programming bugs, etc."* (Barequet, abstract); *"If the original orientation of facets is not consistent, we need to make the following modifications to our algorithm: Orient all the facets of each connected component consistently with respect to other facets in the component..."* (Barequet, page 366, "4.2

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Orientation Checking"); *"The algorithm is also able to detect non-orientable surfaces while processing a "back-edge" in the depth-first order traversal. Back-edges are used to perform a consistency check between two facets whose respective orientations are already fixed. If the two orientation do not match, the component is non-orientable and the system reports the error as such."* (Barequet, page 365, "2 Computing the Connected Components")].

Sebastian in view of Shebini and Barequet are analogous art because both are directed to CAD modeling.

It would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian in view of Shebini with Barequet as expressly motivated by Barequet to identify and correct problems in the CAD model [*"File formats like IGES ... DXF ... and STL ... (which is a de facto standard in the rapid-prototyping industry) allow users to represent models as such soups of polygons... The collection of polygons is assumed to represent a complete model. Unfortunately this is often not the case. Typical problems include cracks (in the surface), degeneracies, duplication (of patches of the surface), holes and overlaps, as shown in Figure 1... We present algorithms to eliminate dangling geometry, T-joins, holes and cracks in a polygonal solid model, and generate consistent polygon-orientations."* (Barequet, page 363, "1 Introduction")]. The combination could be achieved by using Barequet's algorithms in the system and method described by Sebastian in view of Shebini to identify and correct the same types of errors in Sebastian's CAD models. The combination would produce a system as described by Sebastian in view of Shebini but enhanced with the error identification and correction techniques taught by Barequet.

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Therefore it would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian, Shebini, and Barequet to arrive at the invention specified in claim 13.

Regarding claim 14, Sebastian teaches:

A design support method which holds a series of design work histories as work history data in order for reuse and generates a shape by a computer according to the work history data according to an instruction input to a processor [(abstract); (column 11, lines 32-49); (column 12, lines 3-11); (column 13, lines 44-46)], comprising the steps of:

Analyzing the work history data by sequentially reproducing unit work history data upon input to the processor to extract the input work performed by a person in charge of work (column 22, lines 21-65);

Showing the extracted input work to the person in charge of work to request input of design support information;

when the design support information is input, recording the design support information in the work history data [(column 11, lines 32-49); (column 22, lines 21-65)]; and

creating a corresponding surface group and determining, using the corresponding surface group, errors in the extracted input work arising from the second reference surface [See column 22, *et seq.*, in particular: *"The designer starts by instantiating the nominal wall feature and uses the add-on operation to provide "Fasten" functionality. In this example, the system searches for a function template using "Fasten" as the search criteria and provides the user with the boss feature. The user specifies the parameters for the boss such as dimension and positioning information. Based on the selection, the reasoning attributes of the feature template are*

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evaluated and the system examines the appropriate constraints. The constraints retrieve necessary additionally information from other feature templates, look-up tables and the material database 90. The constraints that pertain to the feature "boss" are evaluated, and it is found that the thickness of the boss is adequate to support the applied load. However, while considering the mold fill criteria, the thickness exceeds the manufacturer's recommendation (as retrieved from the manufacturer's external database) for the selected material. Depending on the constraint evaluation results, the user is notified through one of the following mechanisms: warning messages, error messages and design change recommendations... In the boss example, the system notifies the user that the "BOSS IS TOO THICK" and recommends a range of appropriate thickness values for the selected material that satisfies both the mold fill and the strength criteria." (column 22, line 18, et seq.)].

Sebastian does not expressly teach a database accumulating technical conditions as claimed, or that the errors determined using the corresponding surface group include the types recited by the claim.

Shebini teaches the database accumulating technical conditions, which are to be met by the part shape model to be created according to each work history data, in association with each work history data [*"Turning to very particular structures, namely off-shore platforms, we see that they must be structurally adequate for operational and environmental loading, practical to construct, and be cost effective. The selection of a configuration is based on functional requirements and methods of installation."* (Shebini, column 3, lines 60-65); *"Once environmental loads are determined, they are combined with operational loads, and an estimate is made of the resulting pile mudline moments and axial forces."* (Shebini, column 4, lines 33-

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39); *"Before the design solution of either the 3-dimensional "finite Element" analysis of the superstructure and jacket, or the beam-column analysis of the piling can be considered finished, it is necessary to determine compatible conditions at the pilehead-structure interface. These equilibrium conditions are usually obtained using an interaction analysis procedure which yields the combined response of the linear structure and its non-linear soil-pile foundation for any imposed static load condition."* (Shebini, column 4, lines 55-65); et cetera. Shebini provides numerous examples of the "technical conditions" that are accumulated in columns 3 and 4];

computing at least one technical characteristic value of the shape which is created based on the fetched work history data [*"The equilibrium conditions determined from the interaction analysis are now imposed on the structural Model in combination with appropriate design loads, and a static analysis is performed. The internal member forces determined in this analysis are employed to check the stress levels in the members."* (Shebini, column 4, line 65 - column 5, line 2)]; and

comparing the computed technical characteristic value with technical conditions related to work history data [*"The stresses are compared to allowable stresses, as set forth in the design basis, and members resized accordingly."* (Shebini, column 5, lines 2-5)];

wherein the computation of the at least one technical characteristic value comprises analyzing the strength of the one-piece shape model [*"stress levels in the members"* (Shebini, column 4, line 65 - column 5, line 5)].

Sebastian and Shebini are analogous art because both are drawn to structural modeling.

It would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian and Shebini as expressly motivated

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by Shebini in order to predict the structural properties of the assembled product [*"Nowadays, by using the Finite Element Method (FEM), stress analysts do not have to modify the problem to conform to available solutions. No matter how complex the shape or system of loads may be, the (FEM) treats a loaded structure as being built of numerous tiny connected substructures or elements as are shown in FIG. 8. Since these elements can be put together in virtually any fashion, they can be arranged in simulate exceedingly complex shapes. Thus, the (FEM) can be used to determine stresses for structural parts where no mathematically closed form solution exists."* (Shebini, column 1, lines 25-35)]. The combination could be achieved by using Shebini's structural analysis method to analyze the model described by Sebastian.

Sebastian in view of Shebini does not expressly teach that the errors determined using the corresponding surface group include the types recited by the claim.

Barequet teaches determining errors using a corresponding surface group, the errors including at least one of a change of a number of configuring surfaces, a change in direction or quantity of border lines, reversal of a direction of a surface, and a folding of a surface [*"We describe an algorithm for repairing polyhedral CAD models that have errors in their B-REP. Errors like cracks, degeneracies, duplication, holes and overlaps are usually introduced in solid models due to imprecise arithmetic, model transformations, designer's fault, programming bugs, etc."* (Barequet, abstract); *"If the original orientation of facets is not consistent, we need to make the following modifications to our algorithm: Orient all the facets of each connected component consistently with respect to other facets in the component..."* (Barequet, page 366, "4.2 Orientation Checking"); *"The algorithm is also able to detect non-orientable surfaces while processing a "back-edge" in the depth-first order traversal. Back-edges are used to perform a*

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consistency check between two facets whose respective orientations are already fixed. If the two orientation do not match, the component is non-orientable and the system reports the error as such." (Barequet, page 365, "2 Computing the Connected Components")].

Sebastian in view of Shebini and Barequet are analogous art because both are directed to CAD modeling.

It would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian in view of Shebini with Barequet as expressly motivated by Barequet to identify and correct problems in the CAD model [*"File formats like IGES ... DXF ... and STL ... (which is a de facto standard in the rapid-prototyping industry) allow users to represent models as such soups of polygons... The collection of polygons is assumed to represent a complete model. Unfortunately this is often not the case. Typical problems include cracks (in the surface), degeneracies, duplication (of patches of the surface), holes and overlaps, as shown in Figure 1... We present algorithms to eliminate dangling geometry, T-joins, holes and cracks in a polygonal solid model, and generate consistent polygon-orientations.*" (Barequet, page 363, "1 Introduction")]. The combination could be achieved by using Barequet's algorithms in the system and method described by Sebastian in view of Shebini to identify and correct the same types of errors in Sebastian's CAD models. The combination would produce a system as described by Sebastian in view of Shebini but enhanced with the error identification and correction techniques taught by Barequet.

Therefore it would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian, Shebini, and Barequet to arrive at the invention specified in claim 14.

Regarding claim 15, Sebastian teaches:

A design support method, comprising the steps of:

Accumulating, using a computer, unit work history data which is formed by dividing a history of past design work into work units, comprising a first reference surface, determined for a design target and contains design support information related to input work among the design work;

Showing the unit work history selectively upon receiving designation of the design target by the computer;

Creating a shape, comprising a second reference surface, by sequentially reproducing the selected unit work history;

Providing the design support information related to input work when the input work is demanded while the unit work history is being reproduced [(abstract); (column 11, lines 32-49); (column 12, lines 3-11); (column 13, lines 44-46); (column 22, lines 21-65). This claim presents a combination of limitations recited by previous claims. These citations of the prior art are explained in more detail in the context of the previous claims.]; and

creating a corresponding surface group; and determining, using the corresponding surface group, errors in the shape arising from the second reference surface [See column 22, *et seq.*, in particular: *"The designer starts by instantiating the nominal wall feature and uses the add-on operation to provide "Fasten" functionality. In this example, the system searches for a function template using "Fasten" as the search criteria and provides the user with the boss feature. The user specifies the parameters for the boss such as dimension and positioning information. Based*

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on the selection, the reasoning attributes of the feature template are evaluated and the system examines the appropriate constraints. The constraints retrieve necessary additionally information from other feature templates, look-up tables and the material database 90. The constraints that pertain to the feature "boss" are evaluated, and it is found that the thickness of the boss is adequate to support the applied load. However, while considering the mold fill criteria, the thickness exceeds the manufacturer's recommendation (as retrieved from the manufacturer's external database) for the selected material. Depending on the constraint evaluation results, the user is notified through one of the following mechanisms: warning messages, error messages and design change recommendations... In the boss example, the system notifies the user that the "BOSS IS TOO THICK" and recommends a range of appropriate thickness values for the selected material that satisfies both the mold fill and the strength criteria." (column 22, line 18, et seq.)].

Sebastian does not expressly teach a database accumulating technical conditions as claimed, or that the errors determined using the corresponding surface group include the types recited by the claim.

Shebini teaches the accumulating, using the computer, technical conditions, which are to be met by a part shape model to be created according to each work history data, in association with each work history data [*"Turning to very particular structures, namely off-shore platforms, we see that they must be structurally adequate for operational and environmental loading, practical to construct, and be cost effective. The selection of a configuration is based on functional requirements and methods of installation."* (Shebini, column 3, lines 60-65); *"Once environmental loads are determined, they are combined with operational loads, and an estimate*

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is made of the resulting pile mudline moments and axial forces." (Shebini, column 4, lines 33-39); *"Before the design solution of either the 3-dimensional "finite Element" analysis of the superstructure and jacket, or the beam-column analysis of the piling can be considered finished, it is necessary to determine compatible conditions at the pilehead-structure interface. These equilibrium conditions are usually obtained using an interaction analysis procedure which yields the combined response of the linear structure and its non-linear soil-pile foundation for any imposed static load condition."* (Shebini, column 4, lines 55-65); et cetera. Shebini provides numerous examples of the "technical conditions" that are accumulated in columns 3 and 4];

computing at least one technical characteristic value of the shape which is created based on the work history data [*"The equilibrium conditions determined from the interaction analysis are now imposed on the structural Model in combination with appropriate design loads, and a static analysis is performed. The internal member forces determined in this analysis are employed to check the stress levels in the members."* (Shebini, column 4, line 65 - column 5, line 2)]; and

comparing the computed technical characteristic value with technical conditions related to unit work history data [*"The stresses are compared to allowable stresses, as set forth in the design basis, and members resized accordingly."* (Shebini, column 5, lines 2-5)];

wherein the computation of the at least one technical characteristic value comprises analyzing the strength of the shape [*"stress levels in the members"* (Shebini, column 4, line 65 - column 5, line 5)].

Sebastian and Shebini are analogous art because both are drawn to structural modeling.

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It would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian and Shebini as expressly motivated by Shebini in order to predict the structural properties of the assembled product [*"Nowadays, by using the Finite Element Method (FEM), stress analysts do not have to modify the problem to conform to available solutions. No matter how complex the shape or system of loads may be, the (FEM) treats a loaded structure as being built of numerous tiny connected substructures or elements as are shown in FIG. 8. Since these elements can be put together in virtually any fashion, they can be arranged in simulate exceedingly complex shapes. Thus, the (FEM) can be used to determine stresses for structural parts where no mathematically closed form solution exists."* (Shebini, column 1, lines 25-35)]. The combination could be achieved by using Shebini's structural analysis method to analyze the model described by Sebastian.

Sebastian in view of Shebini does not expressly teach that the errors determined using the corresponding surface group include the types recited by the claim.

Barequet teaches determining errors using a corresponding surface group, the errors including at least one of a change of a number of configuring surfaces, a change in direction or quantity of border lines, reversal of a direction of a surface, and a folding of a surface [*"We describe an algorithm for repairing polyhedral CAD models that have errors in their B-REP. Errors like cracks, degeneracies, duplication, holes and overlaps are usually introduced in solid models due to imprecise arithmetic, model transformations, designer's fault, programming bugs, etc."* (Barequet, abstract); *"If the original orientation of facets is not consistent, we need to make the following modifications to our algorithm: Orient all the facets of each connected component consistently with respect to other facets in the component..."* (Barequet, page 366, "4.2

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Orientation Checking"); *"The algorithm is also able to detect non-orientable surfaces while processing a "back-edge" in the depth-first order traversal. Back-edges are used to perform a consistency check between two facets whose respective orientations are already fixed. If the two orientation do not match, the component is non-orientable and the system reports the error as such."* (Barequet, page 365, "2 Computing the Connected Components")].

Sebastian in view of Shebini and Barequet are analogous art because both are directed to CAD modeling.

It would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian in view of Shebini with Barequet as expressly motivated by Barequet to identify and correct problems in the CAD model [*"File formats like IGES ... DXF ... and STL ... (which is a de facto standard in the rapid-prototyping industry) allow users to represent models as such soups of polygons... The collection of polygons is assumed to represent a complete model. Unfortunately this is often not the case. Typical problems include cracks (in the surface), degeneracies, duplication (of patches of the surface), holes and overlaps, as shown in Figure 1... We present algorithms to eliminate dangling geometry, T-joins, holes and cracks in a polygonal solid model, and generate consistent polygon-orientations."* (Barequet, page 363, "1 Introduction")]. The combination could be achieved by using Barequet's algorithms in the system and method described by Sebastian in view of Shebini to identify and correct the same types of errors in Sebastian's CAD models. The combination would produce a system as described by Sebastian in view of Shebini but enhanced with the error identification and correction techniques taught by Barequet.

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Therefore it would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian, Shebini, and Barequet to arrive at the invention specified in claim 15.

Regarding claim 16, Sebastian teaches wherein it is judged whether the work history to be reproduced conforms to predetermined guidance display conditions while the unit work history data is being reproduced by the computer and, if it conforms to the guidance display conditions, a guidance display determined in connection with the guide display conditions is performed (column 22, lines 21-65).

Regarding claim 17, Sebastian teaches a recording medium storing a design support program and being computer-readable, the design support program comprising:

A module holding a series of design work histories as a plurality of work history data, comprising a first reference surface, for creation of a part shape model, comprising a second reference surface [(abstract); (column 11, lines 32-49); (column 12, lines 3-11); (column 13, lines 44-46)];

A module fetching at least two selected work history data from the held multiple work history data (column 22, lines 21-65); and

A module for outputting design work data for creating a one-piece shape model by sequentially reproducing unit work history data and combining the at least two fetched work history data and connecting part shape models corresponding to the respective work history data (column 12, lines 3-11); and

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a module creating a corresponding surface group in accordance with user input of a correspondence; and a module determining, using the corresponding surface group, errors in the part shape model arising from the second reference surface [See column 22, *et seq.*, in particular: *"The designer starts by instantiating the nominal wall feature and uses the add-on operation to provide "Fasten" functionality. In this example, the system searches for a function template using "Fasten" as the search criteria and provides the user with the boss feature. The user specifies the parameters for the boss such as dimension and positioning information. Based on the selection, the reasoning attributes of the feature template are evaluated and the system examines the appropriate constraints. The constraints retrieve necessary additionally information from other feature templates, look-up tables and the material database 90. The constraints that pertain to the feature "boss" are evaluated, and it is found that the thickness of the boss is adequate to support the applied load. However, while considering the mold fill criteria, the thickness exceeds the manufacturer's recommendation (as retrieved from the manufacturer's external database) for the selected material. Depending on the constraint evaluation results, the user is notified through one of the following mechanisms: warning messages, error messages and design change recommendations... In the boss example, the system notifies the user that the "BOSS IS TOO THICK" and recommends a range of appropriate thickness values for the selected material that satisfies both the mold fill and the strength criteria."* (column 22, line 18, *et seq.*)].

Sebastian does not expressly teach a database accumulating technical conditions as claimed, or that the errors determined using the corresponding surface group include the types recited by the claim.

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Shebini teaches a module accumulating technical conditions, which are to be met by a part shape model [*"Turning to very particular structures, namely off-shore platforms, we see that they must be structurally adequate for operational and environmental loading, practical to construct, and be cost effective. The selection of a configuration is based on functional requirements and methods of installation."* (Shebini, column 3, lines 60-65); *"Once environmental loads are determined, they are combined with operational loads, and an estimate is made of the resulting pile mudline moments and axial forces."* (Shebini, column 4, lines 33-39); *"Before the design solution of either the 3-dimensional "finite Element" analysis of the superstructure and jacket, or the beam-column analysis of the piling can be considered finished, it is necessary to determine compatible conditions at the pilehead-structure interface. These equilibrium conditions are usually obtained using an interaction analysis procedure which yields the combined response of the linear structure and its non-linear soil-pile foundation for any imposed static load condition."* (Shebini, column 4, lines 55-65); et cetera. Shebini provides numerous examples of the "technical conditions" that are accumulated in columns 3 and 4];

a module computing at least one technical characteristic value of the one-piece shape model which is created from the design work data [*"The equilibrium conditions determined from the interaction analysis are now imposed on the structural Model in combination with appropriate design loads, and a static analysis is performed. The internal member forces determined in this analysis are employed to check the stress levels in the members."* (Shebini, column 4, line 65 - column 5, line 2)]; and

a module comparing the computed technical characteristic value with technical conditions related to unit work history data which is the origin of the design work data [*"The*

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stresses are compared to allowable stresses, as set forth in the design basis, and members resized accordingly." (Shebini, column 5, lines 2-5)];

wherein the computation of the at least one technical characteristic value comprises analyzing the strength of the one-piece shape model [*"stress levels in the members"* (Shebini, column 4, line 65 - column 5, line 5)].

Sebastian and Shebini are analogous art because both are drawn to structural modeling.

It would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian and Shebini as expressly motivated by Shebini in order to predict the structural properties of the assembled product [*"Nowadays, by using the Finite Element Method (FEM), stress analysts do not have to modify the problem to conform to available solutions. No matter how complex the shape or system of loads may be, the (FEM) treats a loaded structure as being built of numerous tiny connected substructures or elements as are shown in FIG. 8. Since these elements can be put together in virtually any fashion, they can be arranged in simulate exceedingly complex shapes. Thus, the (FEM) can be used to determine stresses for structural parts where no mathematically closed form solution exists."* (Shebini, column 1, lines 25-35)]. The combination could be achieved by using Shebini's structural analysis method to analyze the model described by Sebastian.

Sebastian in view of Shebini does not expressly teach that the errors determined using the corresponding surface group include the types recited by the claim.

Barequet teaches determining errors using a corresponding surface group, the errors including at least one of a change of a number of configuring surfaces, a change in direction or quantity of border lines, reversal of a direction of a surface, and a folding of a surface [*"We*

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describe an algorithm for repairing polyhedral CAD models that have errors in their B-REP. Errors like cracks, degeneracies, duplication, holes and overlaps are usually introduced in solid models due to imprecise arithmetic, model transformations, designer's fault, programming bugs, etc." (Barequet, abstract); *"If the original orientation of facets is not consistent, we need to make the following modifications to our algorithm: Orient all the facets of each connected component consistently with respect to other facets in the component..."* (Barequet, page 366, "4.2 Orientation Checking"); *"The algorithm is also able to detect non-orientable surfaces while processing a "back-edge" in the depth-first order traversal. Back-edges are used to perform a consistency check between two facets whose respective orientations are already fixed. If the two orientation do not match, the component is non-orientable and the system reports the error as such."* (Barequet, page 365, "2 Computing the Connected Components")].

Sebastian in view of Shebini and Barequet are analogous art because both are directed to CAD modeling.

It would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian in view of Shebini with Barequet as expressly motivated by Barequet to identify and correct problems in the CAD model [*"File formats like IGES ... DXF ... and STL ... (which is a de facto standard in the rapid-prototyping industry) allow users to represent models as such soups of polygons... The collection of polygons is assumed to represent a complete model. Unfortunately this is often not the case. Typical problems include cracks (in the surface), degeneracies, duplication (of patches of the surface), holes and overlaps, as shown in Figure 1... We present algorithms to eliminate dangling geometry, T-joins, holes and cracks in a polygonal solid model, and generate consistent polygon-*

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orientations." (Barequet, page 363, "1 Introduction"]]. The combination could be achieved by using Barequet's algorithms in the system and method described by Sebastian in view of Shebini to identify and correct the same types of errors in Sebastian's CAD models. The combination would produce a system as described by Sebastian in view of Shebini but enhanced with the error identification and correction techniques taught by Barequet.

Therefore it would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian, Shebini, and Barequet to arrive at the invention specified in claim 17.

Regarding claim 18, Sebastian teaches:

A recording medium storing a design support program and being computer-readable, the design support program comprising:

A module outputting work data for creating a shape model of a design target in order to create the shape model of the design target conforming to a desired standard shape [(column 11, lines 32-49); (column 12, lines 3-11)];

A module holding a history of design work performed with reference to a first standard shape, comprising a first reference surface, as a plurality of work history data [(column 11, lines 32-49); (column 12, lines 3-11)];

A module receiving designation of data about a second standard shape, comprising a second reference surface, which is a desired standard shape [(column 11, lines 32-49); (column 12, lines 3-11)];

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A module fetching the selected multiple work history data from the held multiple work history data (column 22, lines 21-65); and

A module combining each of the fetched work history data, sequentially reproducing unit work history data, reproducing design work with reference to the designated second standard shape for the design works performed with reference to the first standard shape among the design works contained in the work history data, and outputting work data corresponding to a one-piece shape model conforming to the second standard shape [(abstract); (column 11, lines 32-49); (column 12, lines 3-11); (column 13, lines 44-46); (column 22, lines 21-65). This claim presents a combination of limitations recited by previous claims. These citations of the prior art are explained in more detail in the context of the previous claims.]; and

a module creating a corresponding surface group in accordance with user input of a correspondence; and a module determining, using the corresponding surface group, errors in the second standard shape caused by the second reference surface [See column 22, *et seq.*, in particular: *"The designer starts by instantiating the nominal wall feature and uses the add-on operation to provide "Fasten" functionality. In this example, the system searches for a function template using "Fasten" as the search criteria and provides the user with the boss feature. The user specifies the parameters for the boss such as dimension and positioning information. Based on the selection, the reasoning attributes of the feature template are evaluated and the system examines the appropriate constraints. The constraints retrieve necessary additionally information from other feature templates, look-up tables and the material database 90. The constraints that pertain to the feature "boss" are evaluated, and it is found that the thickness of the boss is adequate to support the applied load. However, while considering the mold fill*

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criteria, the thickness exceeds the manufacturer's recommendation (as retrieved from the manufacturer's external database) for the selected material. Depending on the constraint evaluation results, the user is notified through one of the following mechanisms: warning messages, error messages and design change recommendations... In the boss example, the system notifies the user that the "BOSS IS TOO THICK" and recommends a range of appropriate thickness values for the selected material that satisfies both the mold fill and the strength criteria." (column 22, line 18, et seq.)].

Sebastian does not expressly teach a database accumulating technical conditions as claimed, or that the errors determined using the corresponding surface group include the types recited by the claim.

Shebini teaches a module accumulating technical conditions, which are to be met by a part shape model [*"Turning to very particular structures, namely off-shore platforms, we see that they must be structurally adequate for operational and environmental loading, practical to construct, and be cost effective. The selection of a configuration is based on functional requirements and methods of installation."* (Shebini, column 3, lines 60-65); *"Once environmental loads are determined, they are combined with operational loads, and an estimate is made of the resulting pile mudline moments and axial forces."* (Shebini, column 4, lines 33-39); *"Before the design solution of either the 3-dimensional "finite Element" analysis of the superstructure and jacket, or the beam-column analysis of the piling can be considered finished, it is necessary to determine compatible conditions at the pilehead-structure interface. These equilibrium conditions are usually obtained using an interaction analysis procedure which yields the combined response of the linear structure and its non-linear soil-pile foundation for nay*

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imposed static load condition." (Shebini, column 4, lines 55-65); et cetera. Shebini provides numerous examples of the "technical conditions" that are accumulated in columns 3 and 4];

a module computing at least one technical characteristic value of the one-piece shape model which is created from the design work [*"The equilibrium conditions determined from the interaction analysis are now imposed on the structural Model in combination with appropriate design loads, and a static analysis is performed. The internal member forces determined in this analysis are employed to check the stress levels in the members."* (Shebini, column 4, line 65 - column 5, line 2)]; and

a module comparing the computed technical characteristic value with technical conditions related to unit work history data which is the origin of the design work data [*"The stresses are compared to allowable stresses, as set forth in the design basis, and members resized accordingly."* (Shebini, column 5, lines 2-5)];

wherein the computation of the at least one technical characteristic value comprises analyzing the strength of the one-piece shape model [*"stress levels in the members"* (Shebini, column 4, line 65 - column 5, line 5)].

Sebastian and Shebini are analogous art because both are drawn to structural modeling.

It would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian and Shebini as expressly motivated by Shebini in order to predict the structural properties of the assembled product [*"Nowadays, by using the Finite Element Method (FEM), stress analysts do not have to modify the problem to conform to available solutions. No matter how complex the shape or system of loads may be, the (FEM) treats a loaded structure as being built of numerous tiny connected substructures or*

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elements as are shown in FIG. 8. Since these elements can be put together in virtually any fashion, they can be arranged in simulate exceedingly complex shapes. Thus, the (FEM) can be used to determine stresses for structural parts where no mathematically closed form solution exists." (Shebini, column 1, lines 25-35)]. The combination could be achieved by using Shebini's structural analysis method to analyze the model described by Sebastian.

Sebastian in view of Shebini does not expressly teach that the errors determined using the corresponding surface group include the types recited by the claim.

Barequet teaches determining errors using a corresponding surface group, the errors including at least one of a change of a number of configuring surfaces, a change in direction or quantity of border lines, reversal of a direction of a surface, and a folding of a surface [*"We describe an algorithm for repairing polyhedral CAD models that have errors in their B-REP. Errors like cracks, degeneracies, duplication, holes and overlaps are usually introduced in solid models due to imprecise arithmetic, model transformations, designer's fault, programming bugs, etc."* (Barequet, abstract); *"If the original orientation of facets is not consistent, we need to make the following modifications to our algorithm: Orient all the facets of each connected component consistently with respect to other facets in the component..."* (Barequet, page 366, "4.2 Orientation Checking"); *"The algorithm is also able to detect non-orientable surfaces while processing a "back-edge" in the depth-first order traversal. Back-edges are used to perform a consistency check between two facets whose respective orientations are already fixed. If the two orientation do not match, the component is non-orientable and the system reports the error as such."* (Barequet, page 365, "2 Computing the Connected Components")].

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It would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian in view of Shebini with Barequet as expressly motivated by Barequet to identify and correct problems in the CAD model [*"File formats like IGES ... DXF ... and STL ... (which is a de facto standard in the rapid-prototyping industry) allow users to represent models as such soups of polygons... The collection of polygons is assumed to represent a complete model. Unfortunately this is often not the case. Typical problems include cracks (in the surface), degeneracies, duplication (of patches of the surface), holes and overlaps, as shown in Figure 1... We present algorithms to eliminate dangling geometry, T-joins, holes and cracks in a polygonal solid model, and generate consistent polygon-orientations."* (Barequet, page 363, "1 Introduction")]. The combination could be achieved by using Barequet's algorithms in the system and method described by Sebastian in view of Shebini to identify and correct the same types of errors in Sebastian's CAD models. The combination would produce a system as described by Sebastian in view of Shebini but enhanced with the error identification and correction techniques taught by Barequet.

Therefore it would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian, Shebini, and Barequet to arrive at the invention specified in claim 18.

Regarding claim 19, Sebastian teaches:

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A recording medium storing a design support program and being computer-readable, the design support program comprising:

A module holding a series of design work histories, comprising a first reference surface, to reuse as a work history data (column 13, lines 44-46);

A module analyzing the work history data by sequentially reproducing unit work history data to extract input work performed by a person in charge of work (column 22, lines 21-65);

A module showing the extracted input work, comprising a second reference surface, to the person in charge of work to receive input of design support information (column 22, lines 21-65); and

A module recording the design support information in the work history data when the design support information is input (column 22, lines 21-65); and

a module creating a corresponding surface group in accordance with user input of a correspondence; and a module determining, using the corresponding surface group, errors in the extracted input work arising from the second reference surface [See column 22, *et seq.*, in particular: *"The designer starts by instantiating the nominal wall feature and uses the add-on operation to provide "Fasten" functionality. In this example, the system searches for a function template using "Fasten" as the search criteria and provides the user with the boss feature. The user specifies the parameters for the boss such as dimension and positioning information. Based on the selection, the reasoning attributes of the feature template are evaluated and the system examines the appropriate constraints. The constraints retrieve necessary additionally information from other feature templates, look-up tables and the material database 90. The constraints that pertain to the feature "boss" are evaluated, and it is found that the thickness of*

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the boss is adequate to support the applied load. However, while considering the mold fill criteria, the thickness exceeds the manufacturer's recommendation (as retrieved from the manufacturer's external database) for the selected material. Depending on the constraint evaluation results, the user is notified through one of the following mechanisms: warning messages, error messages and design change recommendations... In the boss example, the system notifies the user that the "BOSS IS TOO THICK" and recommends a range of appropriate thickness values for the selected material that satisfies both the mold fill and the strength criteria." (column 22, line 18, et seq.)].

Sebastian does not expressly teach a database accumulating technical conditions as claimed, or that the errors determined using the corresponding surface group include the types recited by the claim.

Shebini teaches a module accumulating technical conditions, which are to be met by a part shape model to be created according to each work history data, in association with each work history data [*"Turning to very particular structures, namely off-shore platforms, we see that they must be structurally adequate for operational and environmental loading, practical to construct, and be cost effective. The selection of a configuration is based on functional requirements and methods of installation." (Shebini, column 3, lines 60-65); "Once environmental loads are determined, they are combined with operational loads, and an estimate is made of the resulting pile mudline moments and axial forces." (Shebini, column 4, lines 33-39); "Before the design solution of either the 3-dimensional "finite Element" analysis of the superstructure and jacket, or the beam-column analysis of the piling can be considered finished, it is necessary to determine compatible conditions at the pilehead-structure interface. These*

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equilibrium conditions are usually obtained using an interaction analysis procedure which yields the combined response of the linear structure and its non-linear soil-pile foundation for any imposed static load condition." (Shebini, column 4, lines 55-65); et cetera. Shebini provides numerous examples of the "technical conditions" that are accumulated in columns 3 and 4];

a module computing at least one technical characteristic value of the extracted input work which is created from the work history data [*"The equilibrium conditions determined from the interaction analysis are now imposed on the structural Model in combination with appropriate design loads, and a static analysis is performed. The internal member forces determined in this analysis are employed to check the stress levels in the members."* (Shebini, column 4, line 65 - column 5, line 2)]; and

a module comparing the computed technical characteristic value with technical conditions related to work history data [*"The stresses are compared to allowable stresses, as set forth in the design basis, and members resized accordingly."* (Shebini, column 5, lines 2-5)];

wherein the computation of the at least one technical characteristic value comprises analyzing the strength of the extracted input work [*"stress levels in the members"* (Shebini, column 4, line 65 - column 5, line 5)].

Sebastian and Shebini are analogous art because both are drawn to structural modeling.

It would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian and Shebini as expressly motivated by Shebini in order to predict the structural properties of the assembled product [*"Nowadays, by using the Finite Element Method (FEM), stress analysts do not have to modify the problem to conform to available solutions. No matter how complex the shape or system of loads may be,*

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the (FEM) treats a loaded structure as being built of numerous tiny connected substructures or elements as are shown in FIG. 8. Since these elements can be put together in virtually any fashion, they can be arranged in simulate exceedingly complex shapes. Thus, the (FEM) can be used to determine stresses for structural parts where no mathematically closed form solution exists." (Shebini, column 1, lines 25-35)]. The combination could be achieved by using Shebini's structural analysis method to analyze the model described by Sebastian.

Sebastian in view of Shebini does not expressly teach that the errors determined using the corresponding surface group include the types recited by the claim.

Barequet teaches determining errors using a corresponding surface group, the errors including at least one of a change of a number of configuring surfaces, a change in direction or quantity of border lines, reversal of a direction of a surface, and a folding of a surface [*"We describe an algorithm for repairing polyhedral CAD models that have errors in their B-REP. Errors like cracks, degeneracies, duplication, holes and overlaps are usually introduced in solid models due to imprecise arithmetic, model transformations, designer's fault, programming bugs, etc."* (Barequet, abstract); *"If the original orientation of facets is not consistent, we need to make the following modifications to our algorithm: Orient all the facets of each connected component consistently with respect to other facets in the component..."* (Barequet, page 366, "4.2 Orientation Checking"); *"The algorithm is also able to detect non-orientable surfaces while processing a "back-edge" in the depth-first order traversal. Back-edges are used to perform a consistency check between two facets whose respective orientations are already fixed. If the two orientation do not match, the component is non-orientable and the system reports the error as such."* (Barequet, page 365, "2 Computing the Connected Components")].

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It would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian in view of Shebini with Barequet as expressly motivated by Barequet to identify and correct problems in the CAD model [*"File formats like IGES ... DXF ... and STL ... (which is a de facto standard in the rapid-prototyping industry) allow users to represent models as such soups of polygons... The collection of polygons is assumed to represent a complete model. Unfortunately this is often not the case. Typical problems include cracks (in the surface), degeneracies, duplication (of patches of the surface), holes and overlaps, as shown in Figure 1... We present algorithms to eliminate dangling geometry, T-joins, holes and cracks in a polygonal solid model, and generate consistent polygon-orientations."* (Barequet, page 363, "1 Introduction")]. The combination could be achieved by using Barequet's algorithms in the system and method described by Sebastian in view of Shebini to identify and correct the same types of errors in Sebastian's CAD models. The combination would produce a system as described by Sebastian in view of Shebini but enhanced with the error identification and correction techniques taught by Barequet.

Therefore it would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian, Shebini, and Barequet to arrive at the invention specified in claim 19.

Regarding claim 20, Sebastian teaches:

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A recording medium storing a design support program and being computer-readable, the design support program comprising:

A module accumulating unit work history data which is formed by dividing a history of past design work into work units, comprising a first reference surface, determined for a design target and contains design support information related to input work among the design work [(abstract); (column 11, lines 32-49); (column 12, lines 3-11); (column 13, lines 44-46)];

A module selectively showing the unit work history upon receiving designation of the design target (column 22, lines 21-65);

A module creating a shape, comprising a second reference surface, by sequentially reproducing the selected unit work history [(column 11, lines 32-49); (column 12, lines 3-11)]; and

A module providing design support information related to an input work when the input work is demanded while the unit work history is being reproduced (column 16, lines 19-47); and

a module creating a corresponding surface group in accordance with user input of a correspondence; and a module determining, using the corresponding surface group, errors in the shape arising from the second reference surface [See column 22, *et seq.*, in particular: "*The designer starts by instantiating the nominal wall feature and uses the add-on operation to provide "Fasten" functionality. In this example, the system searches for a function template using "Fasten" as the search criteria and provides the user with the boss feature. The user specifies the parameters for the boss such as dimension and positioning information. Based on the selection, the reasoning attributes of the feature template are evaluated and the system examines the appropriate constraints. The constraints retrieve necessary additionally*

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information from other feature templates, look-up tables and the material database 90. The constraints that pertain to the feature "boss" are evaluated, and it is found that the thickness of the boss is adequate to support the applied load. However, while considering the mold fill criteria, the thickness exceeds the manufacturer's recommendation (as retrieved from the manufacturer's external database) for the selected material. Depending on the constraint evaluation results, the user is notified through one of the following mechanisms: warning messages, error messages and design change recommendations... In the boss example, the system notifies the user that the "BOSS IS TOO THICK" and recommends a range of appropriate thickness values for the selected material that satisfies both the mold fill and the strength criteria." (column 22, line 18, et seq.)].

Sebastian does not expressly teach a database accumulating technical conditions as claimed, or that the errors determined using the corresponding surface group include the types recited by the claim.

Shebini teaches a module accumulating technical conditions, which are to be met by a part shape model to be created according to each unit work history data, in association with each unit work history data [*"Turning to very particular structures, namely off-shore platforms, we see that they must be structurally adequate for operational and environmental loading, practical to construct, and be cost effective. The selection of a configuration is based on functional requirements and methods of installation."* (Shebini, column 3, lines 60-65); *"Once environmental loads are determined, they are combined with operational loads, and an estimate is made of the resulting pile mudline moments and axial forces."* (Shebini, column 4, lines 33-39); *"Before the design solution of either the 3-dimensional "finite Element" analysis of the*

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superstructure and jacket, or the beam-column analysis of the piling can be considered finished, it is necessary to determine compatible conditions at the pilehead-structure interface. These equilibrium conditions are usually obtained using an interaction analysis procedure which yields the combined response of the linear structure and its non-linear soil-pile foundation for any imposed static load condition." (Shebini, column 4, lines 55-65); et cetera. Shebini provides numerous examples of the "technical conditions" that are accumulated in columns 3 and 4];

a module computing at least one technical characteristic value of the shape which is created from the work history data [*"The equilibrium conditions determined from the interaction analysis are now imposed on the structural Model in combination with appropriate design loads, and a static analysis is performed. The internal member forces determined in this analysis are employed to check the stress levels in the members.*" (Shebini, column 4, line 65 - column 5, line 2)]; and

a module comparing the computed technical characteristic value with technical conditions related to work history data [*"The stresses are compared to allowable stresses, as set forth in the design basis, and members resized accordingly.*" (Shebini, column 5, lines 2-5)];

wherein the computation of the at least one technical characteristic value comprises analyzing the strength of the shape [*"stress levels in the members"* (Shebini, column 4, line 65 - column 5, line 5)].

Sebastian and Shebini are analogous art because both are drawn to structural modeling.

It would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian and Shebini as expressly motivated by Shebini in order to predict the structural properties of the assembled product [*"Nowadays, by*

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using the Finite Element Method (FEM), stress analysts do not have to modify the problem to conform to available solutions. No matter how complex the shape or system of loads may be, the (FEM) treats a loaded structure as being built of numerous tiny connected substructures or elements as are shown in FIG. 8. Since these elements can be put together in virtually any fashion, they can be arranged in simulate exceedingly complex shapes. Thus, the (FEM) can be used to determine stresses for structural parts where no mathematically closed form solution exists." (Shebini, column 1, lines 25-35)]. The combination could be achieved by using Shebini's structural analysis method to analyze the model described by Sebastian.

Sebastian in view of Shebini does not expressly teach that the errors determined using the corresponding surface group include the types recited by the claim.

Barequet teaches determining errors using a corresponding surface group, the errors including at least one of a change of a number of configuring surfaces, a change in direction or quantity of border lines, reversal of a direction of a surface, and a folding of a surface [*"We describe an algorithm for repairing polyhedral CAD models that have errors in their B-REP. Errors like cracks, degeneracies, duplication, holes and overlaps are usually introduced in solid models due to imprecise arithmetic, model transformations, designer's fault, programming bugs, etc."* (Barequet, abstract); *"If the original orientation of facets is not consistent, we need to make the following modifications to our algorithm: Orient all the facets of each connected component consistently with respect to other facets in the component..."* (Barequet, page 366, "4.2 Orientation Checking"); *"The algorithm is also able to detect non-orientable surfaces while processing a "back-edge" in the depth-first order traversal. Back-edges are used to perform a consistency check between two facets whose respective orientations are already fixed. If the two*

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orientation do not match, the component is non-orientable and the system reports the error as such." (Barequet, page 365, "2 Computing the Connected Components").

Sebastian in view of Shebini and Barequet are analogous art because both are directed to CAD modeling.

It would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian in view of Shebini with Barequet as expressly motivated by Barequet to identify and correct problems in the CAD model [*"File formats like IGES ... DXF ... and STL ... (which is a de facto standard in the rapid-prototyping industry) allow users to represent models as such soups of polygons... The collection of polygons is assumed to represent a complete model. Unfortunately this is often not the case. Typical problems include cracks (in the surface), degeneracies, duplication (of patches of the surface), holes and overlaps, as shown in Figure 1... We present algorithms to eliminate dangling geometry, T-joins, holes and cracks in a polygonal solid model, and generate consistent polygon-orientations.*" (Barequet, page 363, "1 Introduction")]. The combination could be achieved by using Barequet's algorithms in the system and method described by Sebastian in view of Shebini to identify and correct the same types of errors in Sebastian's CAD models. The combination would produce a system as described by Sebastian in view of Shebini but enhanced with the error identification and correction techniques taught by Barequet.

Therefore it would have been obvious to a person of ordinary skill in the art at the time of Applicants' invention to combine the teachings of Sebastian, Shebini, and Barequet to arrive at the invention specified in claim 20.

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Regarding claim 21, Sebastian teaches:

The recording medium being computer-readable according to claim 20, wherein:

The design support program stored in the recording medium further includes a module judging whether the work history to be reproduced agrees with predetermined guidance display conditions while the unit work history is being reproduced and, if the work history agrees with the guidance display conditions, implements a guidance display determined in connection with the conditions [(column 16, lines 19-47); (column 22, lines 21-65)].

Conclusion

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

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Any inquiry concerning this communication or earlier communications from the examiner should be directed to Jason Proctor whose telephone number is (571) 272-3713. The examiner can normally be reached between 8:30 am-4:30 pm M-F.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Paul Rodriguez can be reached at (571) 272-3753. The fax phone number for the organization where this application or proceeding is assigned is (571) 273-8300.

Any inquiry of a general nature or relating to the status of this application should be directed to the TC 2100 Group receptionist: 571-272-2100. Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

/Jason Proctor/
Primary Examiner, Art Unit 2123

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